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Contents

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editorial

Hot Coffee and Peanuts are Medicines for Heart Problems

Scientists led by Dr. Kangbuck of Samsung Hospital in South Korea have found that people who take three to five cups of coffee a day could reduce the coronary artery calcium which is an early indicator of the potentially serious condition 'coronary atherosclerosis'. Otherwise due to the deposit of calcium in the arteries, a large number of problems will arise.

When the arteries become hardened and narrowed, leading to blood clots, this can trigger the potentially deadly heart attacks. Researchers at Vanderbilt University in U.S.A. and Shanghai Cancer Institute have observed the association of peanut and nut consumption with mortality among low income and racially diverse populations. They have found that intake of peanut and nut consumption were associated with fewer deaths, especially due to heart diseases.

They have studied different races because Blacks, Whites and Asians have different life-style and eating habits. But the result of the studies were the same. We have a wealth of information in our Indian books on Ayurveda, Naturopathy and the effects of plants and herbs on various diseases. Homeopathy is also getting increasingly popular. What is needed is a research with scientific conclusions on their effects. This will be a mine of information for the doctors.

Anil Ahlawat
Editor

CHEMISTRY MUSING

Chemistry Musing was started from August '13 issue of Chemistry Today with the suggestion of Shri Mahabir Singh. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / AIPMT / AIIMS / Other PMTs & PETs with additional study material.

In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / AIPMT. The detailed solutions of these problems will be published in next issue of Chemistry Today.

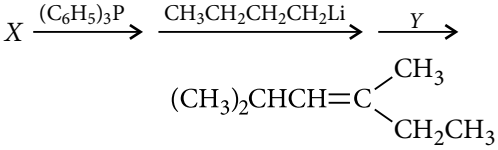
The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue.

We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

PROBLEM Set 21

JEE MAIN/PMTs

1. Which pair of the following compounds could serve as the reagents *X* and *Y* in the following reactions sequence?



I. $(CH_3)_2CHCH_2Br$ II. $(CH_3)_2CHBr$

III. $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HBr$ IV. $(CH_3)_2CHCHO$

V. $CH_3O-\overset{\displaystyle O}{\overset{\|}{C}}-CH_3$

	X	*Y*
(a)	I	V
(b)	I	IV
(c)	II	IV
(d)	III	IV

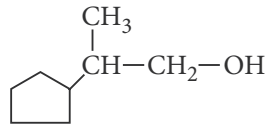
2. F_2 and Cl_2 are completely soluble in water because

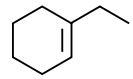
(a) F_2 and Cl_2 are small molecules and can be accommodated in the voids of H_2O

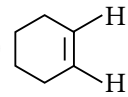
(b) F_2 reacts with H_2O giving HF and O_2 while Cl_2 reacts with H_2O giving HCl and HClO

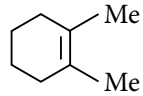
(c) F_2 reacts with H_2O giving HOF while Cl_2 gives HCl and O_2

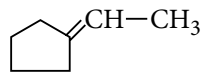
(d) F_2 reacts with H_2O to form HOF whereas Cl_2 reacts with H_2O to give HOCl.

3.  on dehydration gives

(a) 

(b) 

(c) 

(d) 

4. For the reaction, $2Fe^{3+} + Fe \longrightarrow 3Fe^{2+}$, $E^o = 1.21$ V, hence

(a) the reaction occurs even in the absence of a second half-cell or a current

(b) in a complete cell, Fe is anode but Pt is the cathode

(c) Fe cannot be used as cathode, because it would directly react with Fe^{3+}, thus short-circuiting the cell

(d) all of the above are correct.

5. An LPG cylinder weighs 14.8 kg when empty; when full, it weighs 29.0 kg and shows a pressure

Solution Senders of Chemistry Musing

SET 20

1. Anubhab Banerjee (Kolkata)
2. Devarshi Rawal

SET 19

1. Sayantan Adhikary (Kolkata)
2. Tejashwini Patil

of 2.5 atm. In course of use at 27°C, the mass of full cylinder reduced to 23.2 kg. The volume of gas used (in m^3) is
(The major constituent of LPG is *n*-butane.)
(a) 2.46 (b) 22.4 (c) 22.7 (d) 24

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6. A mixture of $Na_2C_2O_4$(*A*) and $KHC_2O_4.H_2C_2O_4$(*B*) required equal volumes of 0.1 M $KMnO_4$ and 0.1 M NaOH separately. Molar ratio of *A* and *B* in the mixture is
(a) 1 : 1 (b) 1 : 5.5 (c) 5.5 : 1 (d) 3.1 : 1

COMPREHENSION

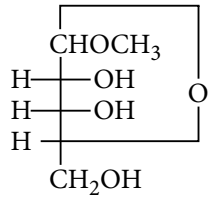
The following observations were made on Na_2CrO_4 and $Na_2Cr_2O_7$.
(i) When CO_2 was passed over Na_2CrO_4, then $Na_2Cr_2O_7$ was formed.
(ii) When Zn is added to acidic solution of $Na_2Cr_2O_7$, the colour changes from orange to green, then to blue and then back to green.

7. What is the function of CO_2 in the first observation?
(a) Acts as an oxidising agent
(b) Acts as a reducing agent
(c) Produces chromium and oxygen
(d) Makes the solution acidic

8. The colour of $Na_2Cr_2O_7$ solution changes from orange to green on adding Zn because
(a) Zn acts as a reducing agent and changes Cr^{4+} to Cr^{3+}
(b) Zn acts as a reducing agent and changes Cr^{6+} to Cr^{3+}
(c) Zn acts as a reducing agent and reduces Cr^{6+} to Cr^{2+}
(d) none of the above.

INTEGER VALUE

9. Total number of moles of HIO_4 required to break down the given molecule is



10. The plot of $\ln t_{1/2}$ and $\ln a_0$ for a reaction is a straight line with slope equal to –2. The order of reaction is

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EXAM ON 24TH MAY

PAPER-I

SECTION-1

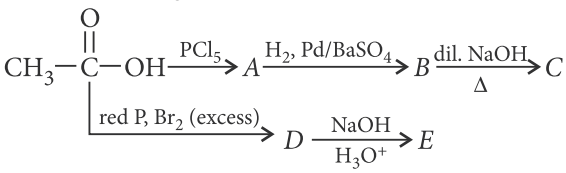
One or More Than One Options Correct Type

This section contains 10 multiple choice type questions. Each question has four choices (a), (b), (c) and (d) out of which ONE or MORE THAN ONE are correct.

1. Two different compounds of Cr(III) have the same empirical formula, $CrCl_3 \cdot 6H_2O$. One (*A*) is green and the other (*B*) is violet. (*A*) on reaction with excess $AgNO_3$ gives one mole of AgCl per mole of (*A*) while (*B*) on reaction with excess $AgNO_3$ gives three moles of AgCl per mole of (*B*).
Choose the correct statements.
(a) (*A*) is $[Cr(H_2O)_6]Cl_3$ and (*B*) is $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$.
(b) (*A*) is a binary salt while (*B*) is a quaternary salt.
(c) Conductance of (*A*) is greater than (*B*).
(d) (*B*) has no effect on heating.

2. If a metallic lattice crystallizes in such a manner that the atoms are arranged in a hexagonal manner in one layer and the repetition is *ABABAB*… of the hexagonal layers, then the
(a) rank of the unit lattice is 6
(b) rank of the unit lattice is 12
(c) volume of the unit lattice is $\left(6 \cdot \frac{\sqrt{3}}{4} \cdot 4r^2\right) \cdot \left(4r \frac{\sqrt{2}}{\sqrt{3}}\right)$
(d) percentage of vacant space = 26.

3. In the following sequence of reactions :



(a) *E* is $\begin{matrix}COOH\\|\\COOH\end{matrix}$ (b) *C* is CH_3COOH
(c) *B* is CH_3CHO (d) *D* is CBr_3CHO

4. A 0.1 M sodium acetate solution was prepared. If the value of K_h is 5.6×10^{-10}, then the
(a) degree of hydrolysis is 7.48×10^{-5}
(b) $[H^+]$ is 1.33×10^{-9} M
(c) $[OH^-]$ is 7.48×10^{-6} M
(d) pH is approximately 8.88.

5. Which of the following statements are correct for the reaction of an alkene with HCl?
(a) A carbocation is formed as an intermediate.
(b) Rearrangements are possible.
(c) Anti-Markovnikov's addition takes place in presence of benzoyl peroxide.
(d) The mechanism can be described as electrophilic addition reaction.

6. A metal chloride '*X*' shows the following reactions:
(i) when H_2S is passed in an acidified aqueous solution of '*X*', a black precipitate is obtained.
(ii) the precipitate obtained at step (i) is not soluble in yellow ammonium sulphide.
(iii) when a solution of stannous chloride is added to an aqueous solution of '*X*', a white precipitate is obtained which turns grey on addition of more of stannous chloride.
(iv) when an aqueous solution of KI is added to an aqueous solution of '*X*', a red precipitate is obtained which dissolves on addition of excess of KI.
Compound '*X*' is
(a) $SnCl_2$ (b) $PbCl_2$
(c) $BaCl_2$ (d) $HgCl_2$

7. Which of the following increase the $\frac{n}{p}$ ratio?
(a) Positron emission (b) K-capture
(c) β-particle emission (d) α-particle emission

8. Which of the following reagents cannot be used for differentiation between CH_3CHO and $CH_3-\overset{\overset{O}{\|}}{C}-Ph$?

(a) NaOI (b) Tollens' reagent
(c) NH_2OH (d) $PhNHNH_2$

9. Which of the following pairs produce same gas?
(a) (Ca_3N_2 + dil. HCl) and (NH_4NO_2 on heating)
(b) ($(NH_4)_2Cr_2O_7$ on heating) and (NH_4NO_2 on heating)
(c) (NH_4NO_3 on heating) and ($Hg(NO_3)_2$ on heating)
(d) (NH_4Cl on heating) and ($NaNO_3$ + Zn + $NaOH_{(aq.)}$ on heating)

10. An organic compound (*A*) $C_4H_7Cl_3$ yields (*B*) with $KOH_{(aq)}$. (*B*) on treating with NH_3 gives (*C*) which on heating gives (*D*). If (*D*) on heating with P_2O_5 gives 2-methylpropanenitrile, then
(a) compound (*A*) is $(CH_3)_2CClCHCl_2$
(b) compound (*C*) is $(CH_3)_2CHCOONH_4$
(c) compound (*D*) is $(CH_3)_2CHCONH_2$
(d) compound (*B*) is $(CH_3)_2CHCOOH$.

SECTION-2

One Integer Value Correct Type

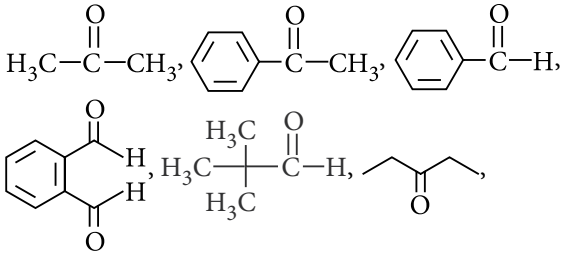
This section contains 10 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive).

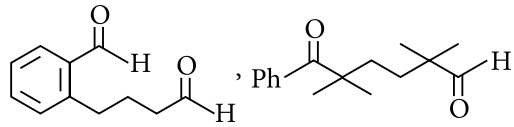
11. An organic compound undergoes first order decomposition. The time taken for its decomposition to 1/8 and 1/10 of its initial concentration are $t_{1/8}$ and $t_{1/10}$ respectively. The value of $\frac{t_{1/8}}{t_{1/10}} \times 10$ is ($\log_{10} 2 = 0.3$)

12. In the given compound,  yne is at position

13. The coordination number exhibited by K^+ when it forms a complex with salicylaldehyde is

14. Of the following compounds, the total number of compounds that would give aldol condensation reaction is



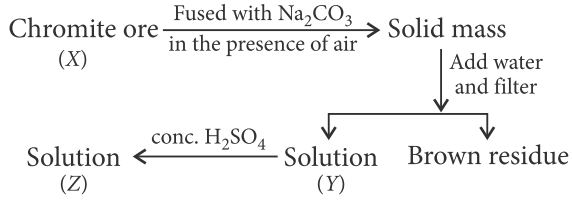


15. A steam engine operates between 400 K and 300 K under high pressure. The minimum amount of heat in kJ that must be withdrawn from the hot reservoir to obtain 1000 joules of work is

16. The number of pairs in which size of first element/ion is higher as compared to second out of the following pairs is
(O, S), (He, Ne), (Kr, Ne), (Na, Na^+), (Cl, Cl^-), (I^-, Cl^-), ($Li^+_{aq.}$, $Na^+_{aq.}$), (Li, Na), (Li^+, Na^+)

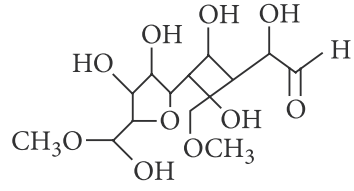
17. The number of free valencies available for adsorption if four Pt atoms are linked together by covalent bonds is

18. Following steps are involved in manufacturing of compound (*Z*) :



The difference in the oxidation number of Cr in (*X*) and (*Z*) is

19. Number of moles of HIO_4 required to oxidise the following compound is



20. A tetrapeptide has —COOH group on alanine. This produces glycine (gly), phenylalanine (phe), valine (val) and alanine (ala) on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary structures) with $—NH_2$ group attached to a chiral centre is

PAPER-II

SECTION-1

Only One Option Correct Type

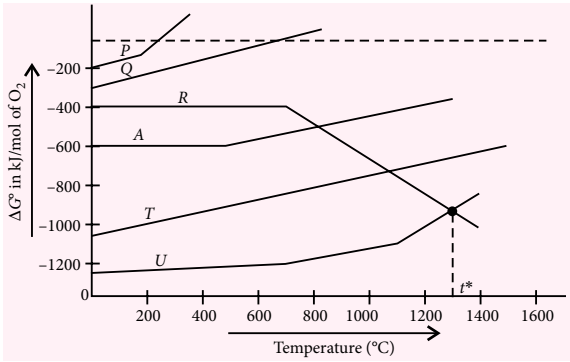
This section contains 10 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which ONLY ONE option is correct.

1. A sample of iron oxide has FeO and Fe_2O_3 in mole ratio 2 : 1. It is partially oxidised to change this ratio

to 1 : 2. Number of moles of FeO oxidised per mole of initial mixture is

(a) 0.2 (b) 0.4 (c) 0.3 (d) 0.6

2. Observe the following graph:



At 1000°C, $2A + O_2 \longrightarrow 2AO$; $\Delta G° = -360$ kJ

$2R + O_2 \longrightarrow 2RO$; $\Delta G° = -460$ kJ

At this temperature,

(a) reduction of AO is not possible by R

(b) reduction of AO is possible by R and metal is obtained in vapour state

(c) $\Delta G° = +50$ kJ for $AO + R \longrightarrow A + RO$ reaction

(d) metal A has more affinity for oxygen as compared to R.

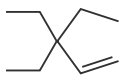
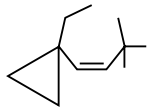
3. An unknown alkyl halide (A) reacts with alcoholic KOH to produce C_4H_8 which on ozonolysis gives one mole of propanone and one mole of formaldehyde. The structure of 'A' is

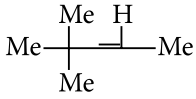
(a) $CH_3-\underset{\displaystyle Br}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-CH_3$ (b) $CH_3-\underset{\displaystyle Br}{CH}-\underset{\displaystyle Br}{CH}-CH_3$

(c) $CH_3-CH_2-\underset{\displaystyle Br}{CH}-CH_3$

(d) $BrCH_2-CH_2-CH_2-CH_2Br$

4. Which of the following will show hyperconjugation?

(a)  (b) 

(c)  (d) 

5. A 10% solution of cane sugar has undergone partial inversion according to the reaction:

Sucrose + Water → Glucose + Fructose

If the boiling point of solution is 100.27°C, the average molecular mass of the dissolved materials and fraction of the sugar that has inverted are $[K_b = 0.52$ K kg mol$^{-1}]$

(a) 342, 0.40 (b) 213.99, 0.40

(c) 342, 0.69 (d) 213.99, 0.60

6. Select the correct statements.

(i) Polarizability of S^{2-} is lower than Se^{2-}.

(ii) Polarizability of S^{2-} is higher than Cl^-.

(iii) Polarizability of S^{2-} is lower than P^{3-}.

(iv) Polarizability of O^{2-} is higher than S^{2-}.

(a) (i), (ii) and (iii) (b) (i) and (ii)

(c) (ii) and (iv) (d) (i), (ii), (iii) and (iv)

7. Read the following statements:

(i) KO_2 is more stable than NaO_2.

(ii) $(NH_4)_2Cr_2O_7$ shows self-redox reaction on heating.

(iii) Products in reaction of metal and nitric acid is independent of concentration.

Select the correct set of statements.

(a) (ii) (b) (i), (ii) (c) (iii) (d) (i)

8. Consider the following reaction:

$$\xleftarrow[S_N1]{C_2H_5OH} CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-CH_2Br \xrightarrow[S_N2]{C_2H_5O^-}$$

$(CH_3)_3CCH_2Br$ shows S_N2 reaction with $C_2H_5O^-$ and S_N1 reaction with C_2H_5OH as given above. Select the correct statement.

(a) Product obtained by S_N2 reaction has inverted configuration.

(b) Product obtained due to S_N1 reaction is a tertiary ether.

(c) Product obtained by S_N1 reaction has inverted configuration.

(d) Product obtained due to S_N2 reaction is a tertiary ether.

9. The wave number of electromagnetic radiation emitted during the transition in between two energy levels of Li^{2+} ion whose principal quantum numbers sum is 4 and difference is 2, is

(a) $3.5\,R_H$ (b) $4\,R_H$ (c) $8\,R_H$ (d) $\frac{8}{9}R_H$

10. 0.535 g of ethanol and acetaldehyde mixture when heated with Fehling's solution gave 1.2 g of a red precipitate. What is the percentage of acetaldehyde in the mixture? (at. wt. of Cu = 63.8)

(a) 68.78% (b) 59.62%

(c) 71.08% (d) 99.25%

SECTION-2

Comprehension Type (Only One Option Correct)

This section contains 3 paragraphs, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with two questions on each paragraph. Each question has only one correct answer among the four given options (a), (b), (c) and (d).

Paragraph for Questions 11 and 12

A compound (*X*) C_4H_5N exists in two stereoisomeric forms. Compound (*X*) on reduction with H_2 in the presence of Ni gives a compound (*Y*). Compound (*Y*) $C_4H_{11}N$ exists in only one form. Compound (*X*) on treatment with alk. $KMnO_4$ followed by acidification gives acetic acid and oxalic acid. When compound (*X*) is reacted with NaOH followed by acidification gives a compound (*Z*) with molecular formula $C_4H_6O_2$. Compound (*Z*) on reaction with alk. $KMnO_4$ followed by acidification gives again oxalic acid and acetic acid. Compound (*Y*) on reaction with $CHCl_3$ and KOH forms a compound (*A*) C_5H_9N. Compound (*Y*) on treatment with HNO_2 followed by reaction with PCC gives a compound (*B*) which gives positive Tollens' test.

11. The compound (*X*) must be

(a) $\underset{\underset{\text{CN}}{|}}{\text{CH}_2}-\text{CH}=\text{CH}_2$ (b) $\text{CH}_3-\underset{\underset{\text{CN}}{|}}{\text{C}}=\text{CH}_2$

(c) $CH_3-CH=CH-CN$

(d) $CH_3-CH=CH-NC$

12. The compound (*Z*) must be

(a) $CH_2=CH-COOCH_3$

(b) $CH_3-CH=CH-COOH$

(c) $CH_3-CH=CH-NC$

(d) $OHCCH_2-CH=CH_2$

Paragraph for Questions 13 and 14

Following data can be taken to fabricate cells for spontaneous reactions.

Consider the following half-cell reactions and corresponding standard reduction potentials:

I.	$A + e^- \longrightarrow A^-$	$E^\circ = -0.24$ V
II.	$B^- + e^- \longrightarrow B^{2-}$	$E^\circ = +1.25$ V
III.	$C^- + 2e^- \longrightarrow C^{3-}$	$E^\circ = -1.25$ V
IV.	$D + 2e^- \longrightarrow D^{2-}$	$E^\circ = +0.68$ V
V.	$E + 4e^- \longrightarrow E^{4-}$	$E^\circ = +0.38$ V

13. Which combination of two half-cells would result in a cell with the largest standard potential?

(a) I and III (b) II and III

(c) I and II (d) IV and V

14. If every ion has concentration 0.1 M in the cell with largest standard potential, then potential of the cell at 298 K is

(a) 2.50 V (b) 1.49 V

(c) 1.06 V (d) 1.91 V

Paragraph for Questions 15 and 16

Propyne can be deprotonated twice with a very strong base like sodamide to give dianion.

$$H^1-C\equiv C-\underset{\underset{H^2}{|}}{\overset{\overset{H^4}{|}}{C}}-H^3 \xrightarrow{\text{Strong base}} [C_3H_2]^{2-}$$

Propyne dianion

Propyne dianion is stabilized by resonance and two resonance forms of the anion can be constructed in which all three carbon atoms have Lewis octets.

15. The hybridisation of carbon atoms in dianion is

(a) sp, sp^2, sp^2 (b) sp, sp, sp

(c) sp^2, sp^2, sp^2 (d) sp, sp, sp^2

16. The hydrogen atoms replaced by the base are

(a) H^1, H^2 (b) H^2, H^3

(c) H^2, H^4 (d) H^3, H^4

SECTION-3

Matching List Type
(Only One Option Correct)

This section contains four questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (a), (b), (c) and (d) out of which one is correct.

17. Match the List-I with List-II and select the correct answer using the code given below the lists:

List-I	List-II
(P) Boyle's temperature	1. $\frac{8a}{27Rb}$
(Q) Inversion temperature	2. $\frac{T}{T_c}$
(R) Critical temperature	3. $\frac{a}{Rb}$
(S) Reduced temperature	4. $\frac{2a}{Rb}$

Code :

	P	Q	R	S
(a)	1	3	2	4
(b)	2	1	3	4
(c)	4	2	1	3
(d)	3	4	1	2

18. Match the List-I with List-II and select the correct answer using the code given below the lists:

List-I (Products)	List-II (Reaction with $CH_3MgBr + H_3O^+$)
(P) $CH_3CH_2CH_2OH$	1. HCHO
(Q) $CH_3\underset{\displaystyle OH}{\underset{\vert}{C}}HCH_3$	2. $CH_3-\overset{\displaystyle O}{\overset{\Vert}{C}}-CH_3$
(R) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{\vert}{\underset{\vert}{C}}}}-OH$	3. CH_3CHO
(S) CH_3CH_2OH	4. $CH_2\!-\!CH_2$ (O bridge)

Code :

	P	Q	R	S
(a)	4	2	1	3
(b)	4	3	2	1
(c)	3	2	1	4
(d)	1	2	4	3

19. Match CFSE given in List-I with electronic configuration in octahedral field given in List-II and select the correct answer using the code given below the lists:

List-I	List-II
(P) $-0.8\,\Delta_o$	1. t_{2g}^3, e_g^2
(Q) zero	2. t_{2g}^5, e_g^0
(R) $-1.2\,\Delta_o$	3. t_{2g}^2, e_g^0
(S) $-2.0\,\Delta_o$	4. t_{2g}^3, e_g^0

Code :

	P	Q	R	S
(a)	3	1	4	2
(b)	4	3	1	2
(c)	3	2	4	1
(d)	2	1	4	3

20. Match the List-I with List-II and select the correct answer using the code given below the lists:

List-I	List-II
(P) $Pt\,\vert\,H_2\,(1\text{ atm})\,\vert\,H^+\,(3\times10^{-4}\text{M})\,\Vert\,H^+\,(M')\,\vert\,H_2\,(1\text{ atm})\,\vert\,Pt$, $E = 0.154$ V	1. $M' = 0.121$ M
(Q) $Ni\vert Ni^{2+}(M')\Vert Cu^{2+}(1M)\vert Cu$, $E = 0.59$ V, $E^\circ_{Ni^{2+}\vert Ni} = -0.25$ V, $E^\circ_{Cu^{2+}\vert Cu} = 0.34$ V	2. $K \approx 10^{37}$
(R) $Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \longrightarrow 2Ag_{(s)} + Zn^{2+}_{(aq)} + 2OH^-_{(aq)}$ when $E^\circ_{cell} = 1.11$ V at 298 K	3. $M' = 1$ M
(S) $2Fe^{3+} + Sn^{2+} \longrightarrow 2Fe^{2+} + Sn^{4+}$, $E^\circ_{Sn^{4+}/Sn^{2+}} = 0.15$ V, $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.771$ V	4. $K \approx 10^{21}$

Code :

	P	Q	R	S
(a)	1	3	2	4
(b)	4	2	1	3
(c)	3	2	1	4
(d)	4	3	2	1

SOLUTIONS

PAPER-I

1. (b, d) : (*A*) is $[Cr(H_2O)_4Cl_2]Cl{\cdot}2H_2O$.
(*B*) is $[Cr(H_2O)_6]Cl_3$.
(*A*) being hydrated complex will loose water on heating and change to $[Cr(H_2O)_4Cl_2]Cl$. (*B*) has no effect of heating as all H_2O molecules are coordinated. (*A*) will ionise as $[Cr(H_2O)_4Cl_2]^+$ and Cl^- hence, it is a binary salt.
(*B*) will ionise as $[Cr(H_2O)_6]^{3+}$ and $3Cl^-$ hence it is a quaternary salt. Hence, conductance of (*B*) is greater than that of (*A*).

2. (a, c, d) : The *hcp* has 6 atoms in corners of hexagonal prism, 2 end centres and 3 atoms inside the hexagonal cubic system.
Hence, rank = number of atoms per unit lattice

$$= \frac{1}{6}\times12+\frac{1}{2}\times2+3=6$$

Volume of the unit lattice = Area of base × Height
Area of base = 6 × Area of equilateral triangle

$$= 6\times\frac{\sqrt{3}}{4}\times4r^2$$

Height of the unit lattice = $4r\times\frac{\sqrt{2}}{\sqrt{3}}$

Volume of the unit lattice

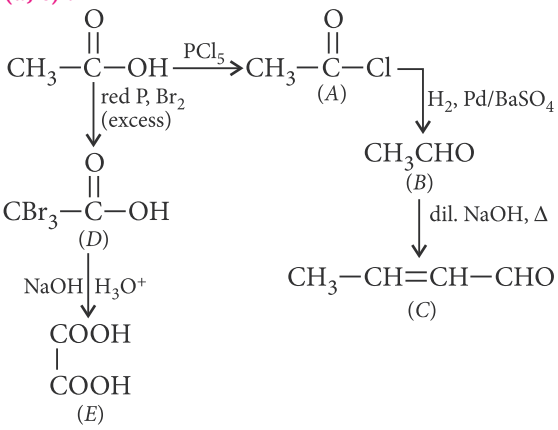
$$= \left(6\times\frac{\sqrt{3}}{4}\times4r^2\right)\left(4r\times\frac{\sqrt{2}}{\sqrt{3}}\right)$$

Volume of atoms inside the lattice = $6\times\frac{4}{3}\pi r^3$

$$\text{Packing fraction} = \frac{6\times\frac{4}{3}\pi r^3}{\left(6\times\frac{\sqrt{3}}{4}\times4r^2\right)\left(4r\times\frac{\sqrt{2}}{\sqrt{3}}\right)} = 0.74$$

Empty space = 0.26
% of empty space = 26

3. (a, c) :



4. (a,b,c,d) : $\underset{0.1\,(1-h)}{CH_3COO^-} + H_2O \rightleftharpoons \underset{0.1\,h}{CH_3COOH} + \underset{0.1\,h}{OH^-}$

$$K_h = \frac{(0.1\,h)(0.1\,h)}{0.1(1-h)} = 0.1\,h^2 \qquad [\because\ h <<<< 1]$$

$$\Rightarrow \quad 5.6 \times 10^{-10} = 0.1\,h^2 \Rightarrow h = 7.48 \times 10^{-5}$$

$$[OH^-] = 0.1\,h = 0.1 \times 7.48 \times 10^{-5}$$

$$= 7.48 \times 10^{-6}\ M$$

$$[H^+] = \frac{K_w}{[OH^-]} = \frac{10^{-14}}{7.48 \times 10^{-6}} = 1.33 \times 10^{-9}\ M$$

$$pH = -\log[H^+] = -\log(1.33 \times 10^{-9}) = 8.88$$

5. (a, b, d): Peroxide effect is applicable only to the addition of HBr.

6. (d): (X) is $HgCl_2$.

(i) $HgCl_2 + H_2S \longrightarrow \underset{\text{black ppt.}}{HgS\downarrow} + 2HCl$

(iii) $2HgCl_2 + SnCl_2 \longrightarrow \underset{\text{white ppt.}}{Hg_2Cl_2\downarrow} + SnCl_4$

$Hg_2Cl_2 + SnCl_2 \longrightarrow \underset{\text{grey ppt.}}{2Hg\downarrow} + SnCl_4$

(iv) $HgCl_2 + 2KI \longrightarrow \underset{\text{red ppt.}}{HgI_2\downarrow} + 2KCl$

$HgI_2 + 2KI \longrightarrow \underset{\text{soluble}}{K_2HgI_4}$

7. (a,b,d) : $\frac{n}{p}$ ratio increases during positron emission because proton gets converted into neutron.

K-capture means capture of electrons which will convert proton into neutron hence leads to increase in $\frac{n}{p}$ ratio.

$${}^1_1p + {}^0_{-1}e \longrightarrow {}^1_0n$$

β-particle emission leads to decrease in $\frac{n}{p}$ ratio.

α-particle emission leads to increase in $\frac{n}{p}$ ratio.

8. (a, c, d)

9. (b, d) : (a) $Ca_3N_2 + 6HCl_{(dil.)} \longrightarrow 2NH_3 + 3CaCl_2$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

(b) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

(c) $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

$Hg(NO_3)_2 \xrightarrow{\Delta} Hg + 2NO_2 + O_2$

(d) $NH_4Cl \xrightarrow{\Delta} NH_3 + HCl$

$NaNO_3 + 4Zn + 7NaOH \xrightarrow{\Delta} NH_3 + 4Na_2ZnO_2 + 2H_2O$

10. (b, c, d) : (D) on heating with P_2O_5 gives 2-methylpropanenitrile so, (D) is $(CH_3)_2CHCONH_2$ (2-Methylpropanamide)

$$\underset{(D)}{(CH_3)_2CHCONH_2} \xrightarrow[\Delta]{P_2O_5} \underset{\text{2-Methylpropanenitrile}}{(CH_3)_2CHCN} + H_2O$$

(D) is also formed by heating the compound (C), whereas (C) is formed by the action of (B) over NH_3. Thus, (B) is an acid and (C) is its ammonium salt.

$$\underset{\substack{\text{2-Methylpropanoic acid}\\(B)}}{(CH_3)_2CHCOOH} + NH_3 \longrightarrow \underset{\substack{\text{2-Methyl ammonium propanoate}\\(C)}}{(CH_3)_2CHCOONH_4} \xrightarrow[(-H_2O)]{\Delta} \underset{(D)}{(CH_3)_2CHCONH_2}$$

Acid (B) is formed by the hydrolysis of (A) hence, all the three halogens must be present on terminal C-atom. Therefore, (A) is

$$\underset{\substack{\text{1,1,1-Trichloro-2-methylpropane}\\(A)}}{(CH_3)_2CHCCl_3} \xrightarrow{KOH_{(aq.)}} \underset{\substack{\text{2-Methylpropanoic acid}\\(B)}}{(CH_3)_2CHCOOH}$$

11. (9) : For a first order reaction,

$$k = \frac{2.303}{t}\log\frac{C_0}{C_t} \Rightarrow t = \frac{2.303}{k}\log\frac{C_0}{C_t}$$

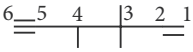
$$\therefore \quad t_{1/8} = \frac{2.303}{k}\log\frac{C_0}{C_0/8} = \frac{2.303}{k}\log 8$$

$$= \frac{2.303}{k}\log 2^3 = \frac{2.303 \times 3}{k}\log 2$$

$$= \frac{2.303 \times 3 \times 0.3}{k}$$

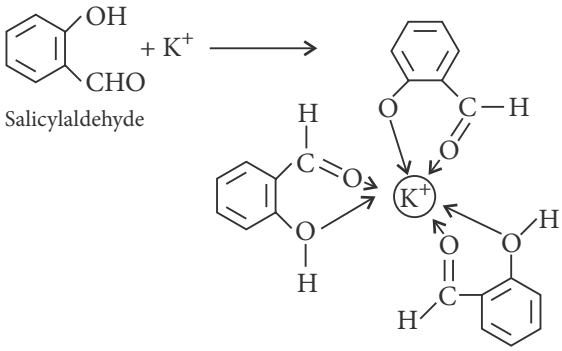
$$t_{1/10} = \frac{2.303}{k}\log\frac{C_0}{C_0/10} = \frac{2.303}{k}\log 10 = \frac{2.303}{k}$$

$$\therefore \quad \frac{t_{1/8}}{t_{1/10}} = 3 \times 0.3 = 0.9 \quad \text{or} \quad \frac{t_{1/8}}{t_{1/10}} \times 10 = 9$$

12. (5): 

Whenever both double and triple bonds are present at terminal positions, double bond is given preference over the triple bond.

13. (6): Potassium gives 6-coordinated complex, $Na[OC_6H_4CHO][HOC_6H_4CHO]_2$.



14. (4): Aldehydes and ketones having at least one α-hydrogen undergo aldol condensation reaction.

15. (4): Given: $T_2 = 400$ K; $T_1 = 300$ K; $-w = 1000$ J

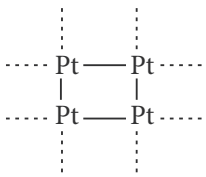
Efficiency $\eta = -w/q_2$ and hence $q_2 = -w/\eta$

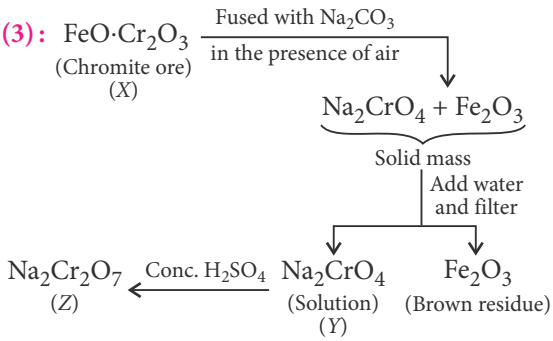
Now $\eta = 1 - \frac{T_1}{T_2} = 1 - \frac{300}{400} = 0.25$

$\therefore \quad q_2 = -w/\eta = \frac{1000\,J}{0.25} = 4000\ J = 4\ kJ$

4 kJ of heat must be withdrawn from the hot reservoir to obtain 1000 joules of work.

16. (4)

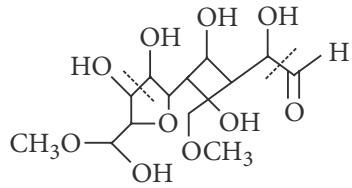
17. (8): 

18. (3): 

O. No. of Cr in $X(FeO{\cdot}Cr_2O_3) = +3$

O. No. of Cr in $Z(Na_2Cr_2O_7) = +6$

19. (2): HIO_4 can oxidise vicinal-diols and α-hydroxy carbonyl compounds. The oxidation of one mole of C—C bond requires one mole of HIO_4.



20. (4): ala has free —COOH group, gly is optically inactive and will not have free $—NH_2$ group.

Possible structures are

H_2N — phe — gly — val — ala — COOH

H_2N — phe — val — gly — ala — COOH

H_2N — val — phe — gly — ala — COOH

H_2N — val — gly — phe — ala — COOH

PAPER-II

1. (b): FeO : Fe_2O_3 = 2 : 1, to be converted to a mixture, FeO : Fe_2O_3 = 1 : 2

$2FeO + \frac{1}{2}O_2 \longrightarrow Fe_2O_3$

x moles of FeO gives $\frac{x}{2}$ moles of Fe_2O_3

$\therefore \quad \frac{2-x}{1+\frac{x}{2}} = \frac{1}{2} \Rightarrow 4 - 2x = 1 + \frac{x}{2}$

$\Rightarrow \quad 5\left(\frac{x}{2}\right) = 3 \Rightarrow x = \frac{6}{5}$

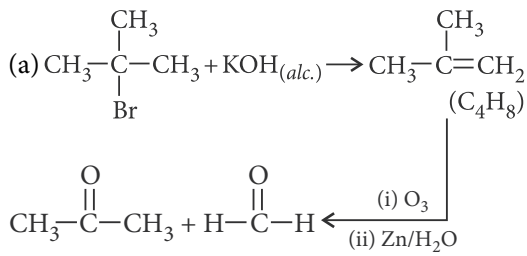
3 moles of mixture has $\frac{6}{5}$ moles of FeO reacted.

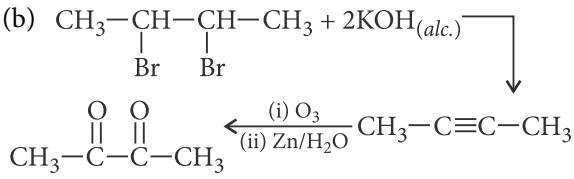
1 mole of mixture has $\frac{6}{5\times 3} = \frac{2}{5} = 0.4$ moles of FeO reacted.

2. (b): At 1000°C, $\Delta G°$ for the reduction of AO by R comes out to be negative so, the reaction is feasible.

$2AO + 2R \longrightarrow 2RO + 2A_{(g)}$; $\Delta G° = -100$ kJ

Metal R has more affinity for oxygen as compared to A as $\Delta G°$ value is more negative for R(–460 kJ) than that of A(–360 kJ).

3. (a): (a) 

(b) 

(c) $CH_3-CH_2-\underset{\underset{Br}{|}}{CH}-CH_3 + KOH_{(alc.)}$ ⟶

$2CH_3-\overset{\overset{O}{\|}}{C}-H \xleftarrow[(ii)\ Zn/H_2O]{(i)\ O_3} CH_3-CH=CH-CH_3$

(d) $BrCH_2-CH_2-CH_2-CH_2Br + KOH_{(alc.)}$ ⟶

$CH_2=CH-CH=CH_2 \xrightarrow[(ii)\ Zn/H_2O]{(i)\ O_3}$

$2H-\overset{\overset{O}{\|}}{C}-H + H-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-H$

4. **(c) :** Me(Me)(H)C–Me contains three α-hydrogen atoms.

5. **(d) :** Let α be the degree of inversion of sugar :

$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O_{(excess)} \longrightarrow \text{Glucose} + \text{Fructose}$

$$i = \frac{(1-\alpha)+\alpha+\alpha}{1} = 1+\alpha$$

Elevation in boiling point,

$\Delta T_b = 100.27\ °C - 100\ °C = 0.27\ °C$

As we know,

$$\Delta T_b = K_b \times \frac{w}{M} \times \frac{1000}{W(\text{in g})},$$

where M = observed mol. wt.

$$0.27 = 0.52 \times \frac{10}{M} \times \frac{1000}{90}$$

$$M = \frac{0.52 \times 10 \times 1000}{0.27 \times 90} = 213.99$$

As we know that, $i = \dfrac{\text{Normal mol. wt.}}{\text{Observed mol. wt.}}$

or $1+\alpha = \dfrac{342}{213.99}$ ∴ $\alpha = 0.59 \approx 0.60$

Average molecular mass of the dissolved materials = 213. 99

Fraction of sugar that has inverted = α = 0.60

6. **(a) :** As the charge and size of anion increases, polarizability increases.

7. **(d) :** (i) Na forms Na_2O_2 on reaction with O_2 while K forms KO_2. The increasing stability of superoxide, as the size of the metal cation increases is due to the stabilisation of larger anions by larger cations.

(ii) The heating of $(NH_4)_2Cr_2O_7$ is a thermal decomposition reaction.

(iii) Different products are obtained in the reaction of metal and nitric acid by varying concentrations.

8. **(b) :**

$$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2Br \xrightarrow[S_N2]{C_2H_5O^-} CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2OC_2H_5$$

(1° ether, optically inactive)

$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2Br \xrightarrow{C_2H_5OH,\ S_N1} CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-\overset{+}{C}H_2 \longrightarrow CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2-CH_3$

$\xrightarrow{C_2H_5O^-}$

$$CH_3-\underset{\underset{OC_2H_5}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2CH_3$$

(3° ether, optically inactive)

9. **(c) :** $n_1 + n_2 = 4$ ...(i)

$n_2 - n_1 = 2$ ...(ii)

$n_1 = 1, n_2 = 3$

$$\bar{\upsilon} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = R_H \times 3^2 \left(\frac{1}{1^1} - \frac{1}{3^2}\right) = 8R_H$$

10. **(a) :** Let a g of C_2H_5OH and b g of CH_3CHO be present in the mixture.

∴ $a + b = 0.535$ g

Now mixture reacts with Fehling's solution to give a red precipitate, which suggests a characteristic reaction for aldehyde, *i.e.*,

$\underset{\text{Fehling's solution}}{CH_3CHO + 2CuO} \longrightarrow \underset{\text{Red ppt.}}{CH_3COOH + Cu_2O\downarrow}$

∵ 143.6 g of Cu_2O is given by 44 g of CH_3CHO

∴ 1.2 g of Cu_2O is given by $\dfrac{44 \times 1.2}{143.6}$

= 0.368 g of CH_3CHO

∴ $b = 0.368$ g

∴ % of $CH_3CHO = \dfrac{0.368}{0.535} \times 100 = 68.78\%$

11. **(c) :** As compound (Y) forms (A) C_5H_9N on treatment with $CHCl_3$ and KOH, (Y) is 1°-amine. Further as (Y) has formula $C_4H_{11}N(C_nH_{2n+3}N)$ hence, it is an aliphatic 1° amine.

$(Y) \xrightarrow{HNO_2} \xrightarrow{PCC} (B)$

and compound (B) gives positive Tollens' test.

B is C_3H_7CHO; Y is $C_3H_7CH_2NH_2$.

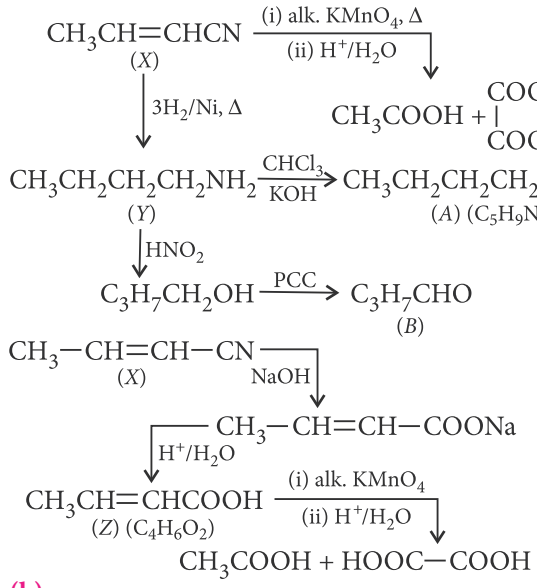
As (Y) is obtained from (X) by hydrogenation,

(X) must be $CH_2=CH-CH_2-CN$ or

$CH_3-CH=CH-CN$

As (X) exists in two isomeric forms,

(X) must be $CH_3-CH=CH-CN$.



12. (b)

13. (b): (a) I and III

$C^{3-}|C^{-}||A|A^{-}$

$E^{\circ}_{cell} = -0.24 - (-1.25) = 1.01$ V

(b) II and III

$C^{3-}|C^{-}||B^{-}|B^{2-}$

$E^{\circ}_{cell} = 1.25 - (-1.25) = 2.5$ V

(c) I and II

$A^{-}|A||B^{-}|B^{2-}$

$E^{\circ}_{cell} = 1.25 - (-0.24) = 1.49$ V

(d) IV and V

$E^{4-}|E||D|D^{2-}$

$E^{\circ}_{cell} = 0.68 - 0.38 = 0.3$ V

14. (a): Cell reaction: $C^{3-} + 2B^{-} \longrightarrow C^{-} + 2B^{2-}$

$E^{\circ}_{cell} = 2.5$ V

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n}\log\frac{[B^{2-}]^2[C^{-}]}{[C^{3-}][B^{-}]^2}$$

$$= 2.5 - \frac{0.0591}{2}\log\frac{(0.1)^2(0.1)}{(0.1)(0.1)^2}$$

$= 2.5 - 0.0295 \log 1 = 2.50$ V

15. (d): The dianion is $\bar{C}\equiv C-\underset{\bar{}}{C}-H$ (sp, sp, sp^2)

16. (a): H^1 is most acidic than others due to *sp* hybridisation so base abstracts this hydrogen first and second hydrogen can be either H^2, H^3 or H^4.

17. (d) **18. (b)**

19. (a): If a metal has t_{2g}^{x}, e_g^{y} configuration, then

CFSE $= (-0.4x + 0.6y)\Delta_o$

(P) t_{2g}^{2}, e_g^{0}

CFSE $= (-0.4 \times 2 + 0.6 \times 0)\Delta_o = -0.8\Delta_o$

(Q) t_{2g}^{3}, e_g^{2}

CFSE $= (-0.4 \times 3 + 0.6 \times 2)\Delta_o = 0$

(R) t_{2g}^{3}, e_g^{0}

CFSE $= (-0.4 \times 3 + 0.6 \times 0)\Delta_o = -1.2\Delta_o$

(S) t_{2g}^{5}, e_g^{0}

CFSE $= (-0.4 \times 5 + 0.6 \times 0)\Delta_o = -2.0\Delta_o$

20. (a): (P) $Pt|\underset{(1atm)}{H_2}|H^{+}(3\times10^{-4}\ M)||H^{+}(M')|\underset{(1\ atm)}{H_2}|Pt$

$$E_{cell} = \frac{0.0591}{n}\log\frac{C_2}{C_1} = \frac{0.0591}{2}\log\frac{(M')^2}{(3\times10^{-4})^2}$$

$$0.154 = \frac{0.0591}{2}\log\frac{(M')^2}{(3\times10^{-4})^2}$$

$$5.211 = \log\frac{(M')^2}{(3\times10^{-4})^2}$$

$$\left(\frac{M'}{3\times10^{-4}}\right)^2 = 162554.87$$

$M' = 0.121$ M

(Q) $Ni|Ni^{2+}(M')||Cu^{2+}(1M)|Cu$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[Ni^{2+}]}{[Cu^{2+}]}$$

$$0.59 = (E^{\circ}_{Cu^{2+}/Cu} - E^{\circ}_{Ni^{2+}/Ni}) - \frac{0.0591}{2}\log\frac{M'}{1}$$

$$0.59 = [0.34 - (-0.25)] - \frac{0.0591}{2}\log M'$$

$$0.59 = 0.59 - \frac{0.0591}{2}\log M'$$

$\Rightarrow \quad M' = 1$ M

(R) At 298 K

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n}\log K$$

At equilibrium, $E_{cell} = 0$

$$E^{\circ}_{cell} = \frac{0.0591}{n}\log K$$

$$1.11 = \frac{0.0591}{2}\log K$$

$2.22 = 0.0591 \log K$

$$\log K = \frac{2.22}{0.0591}$$

$K = 3.6 \times 10^{37} \approx 10^{37}$

(S) $E^{\circ}_{cell} = E^{\circ}_{Fe^{3+}/Fe^{2+}} - E^{\circ}_{Sn^{4+}/Sn^{2+}}$

$= 0.771 - 0.15 = 0.621$ V

$$E^{\circ}_{cell} = \frac{0.0591}{2}\log K$$

$$0.621 = \frac{0.0591}{2}\log K$$

$1.242 = 0.0591 \log K$

$K = 1.03 \times 10^{21} \approx 10^{21}$

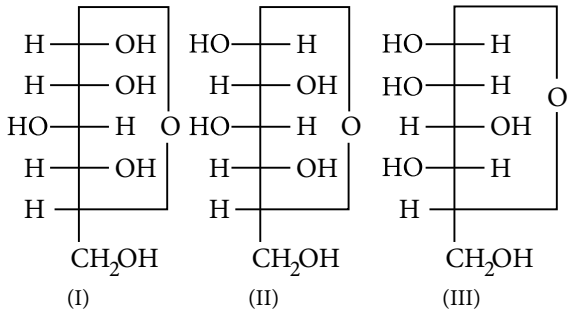
EXAM from
14th to 29th MAY

BITSAT
PRACTICE PAPER

1. The common features among the species CN^-, CO and NO^+ are
   (a) bond order three and isoelectronic
   (b) bond order three and weak field ligands
   (c) bond order two and π-acceptors
   (d) isoelectronic and weak field ligands.

2. Polyphosphates are used as water softening agents because they
   (a) form soluble complexes with anionic species
   (b) precipitate anionic species
   (c) form soluble complexes with cationic species
   (d) precipitate cationic species.

3. Three cyclic structures of monosaccharides are given below. Which of these are anomers?



(I) (II) (III)

   (a) I and II (b) II and III
   (c) I and III (d) III is anomer of I and II.

4. Which of the following sets of quantum numbers represents the highest energy of an atom?
   (a) $n = 3, l = 0, m = 0, s = +\frac{1}{2}$
   (b) $n = 3, l = 1, m = 1, s = +\frac{1}{2}$
   (c) $n = 3, l = 2, m = 1, s = +\frac{1}{2}$
   (d) $n = 4, l = 0, m = 0, s = +\frac{1}{2}$

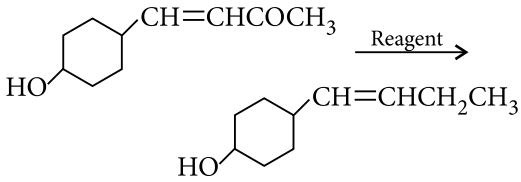
5. Which of the following is likely to be the e.m.f. of the cell (chloride based) shown below?
   $Ag_{(s)}|AgCl(K_{sp})|\ Cl^-(x\ M)||AgCl(K_{sp})|Ag_{(s)}$
   (a) $0.059 \log \frac{x}{\sqrt{K_{sp}}}$
   (b) $0.059 \log [(x)(K_{sp})]$
   (c) $0.059 \log \frac{\sqrt{K_{sp}}}{x}$
   (d) Data is insufficient for calculation.

6. The indicator that is obtained by coupling the diazonium salt of sulphanilic acid with *N*,*N*-dimethylaniline is
   (a) phenanthroline (b) methyl orange
   (c) methyl red (d) phenolphthalein.

7. For adsorption of gas in solid, $\log\left(\frac{x}{m}\right)$ versus $\log p$ is linear with the slope equal to
   (a) K (b) $\log K$
   (c) $\frac{1}{n}$ (d) n

8. $AgNO_3$ reacts with $Na_2S_2O_3$ with a colour change
   (a) white ⟶ yellow ⟶ brown ⟶ black
   (b) white ⟶ red ⟶ brown
   (c) white ⟶ brown ⟶ red
   (d) white ⟶ green ⟶ orange ⟶ red.

9. In the given transformation, which of the following is the most appropriate reagent?



(a) Zn-Hg/HCl (b) Na, liq. NH_3
(c) $NaBH_4$ (d) $NH_2—NH_2$, OH^-

10. A nuclide of an alkaline earth metal undergoes radioactive decay by emission of α-particle in succession to give the stable nucleus. The group of the periodic table to which the resulting daughter element would belong is
(a) Group 4 (b) Group 6
(c) Group 16 (d) Group 14

11. Arrange the following polymers in increasing order of their intermolecular forces.
Nylon-6,6, Buna-S, Polythene
(a) Buna-S < Nylon-6,6 < Polythene
(b) Buna-S < Polythene < Nylon-6,6
(c) Nylon-6,6 < Buna-S < Polythene
(d) Polythene < Buna-S < Nylon-6,6

12. van der Waals' equation for 0.2 mol of a gas is

(a) $\left(P+\frac{a}{V^2}\right)+(V-0.2b)=0.2RT$

(b) $\left(P+\frac{a}{0.04V^2}\right)(V-b)=0.02RT$

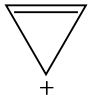
(c) $\left(P+\frac{0.2a}{V^2}\right)(V-0.2b)=0.2RT$

(d) $\left(P+\frac{0.04a}{V^2}\right)(V-0.2b)=0.2RT$

13. The electronegativity of the following elements increases in the order
(a) C, N, Si, P (b) N, Si, C, P
(c) Si, P, C, N (d) P, Si, N, C

14. Which of the following compounds is not aromatic according to Huckle's rule?

(a)  (b) 

(c)  (d) 

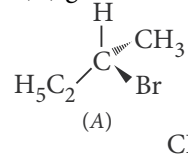
15. The following equilibrium constants are given
$N_2 + 3H_2 \rightleftharpoons 2NH_3$; K_1
$N_2 + O_2 \rightleftharpoons 2NO$; K_2
$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O$; K_3
The equilibrium constant for the oxidation of NH_3 by oxygen to give NO :
$2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$, is

(a) $\frac{K_2K_3^2}{K_1}$ (b) $\frac{K_2^2K_3^6}{K_1^2}$
(c) $\frac{K_1K_2}{K_3}$ (d) $\frac{K_2K_3^3}{K_1}$

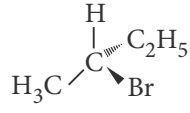
16. Which of the following compounds is not coloured?
(a) $Na_2[CuCl_4]$ (b) $Na_2[CdCl_4]$
(c) $K_4[Fe(CN)_6]$ (d) $K_3[Fe(CN)_6]$

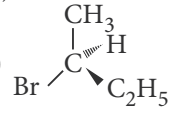
17. Which of the following gases does not contribute to greenhouse effect?
(a) O_3 (b) H_2O vapour
(c) O_2 (d) N_2O

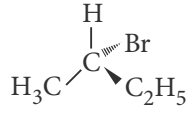
18. Which of the following structures is enantiomeric with the molecule (*A*) given below?

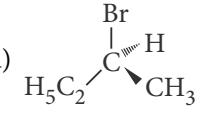


(*A*)

(a) 

(b) 

(c) 

(d) 

19. The atomic masses of He and Ne are 4 and 20 amu respectively. The value of the de Broglie wavelength of He gas at –73°C is '*M*' times that of the de Broglie wavelength of Ne at 727°C. '*M*' is
(a) 2 (b) 3
(c) 4 (d) 5

20. The number of hydroxyl groups in pyrophosphoric acid is
(a) 3 (b) 4
(c) 5 (d) 7

21. The order of decreasing stability of the given carbanions is
(I) $(CH_3)_3C^-$ (II) $(CH_3)_2CH^-$
(III) $CH_3CH_2^-$ (IV) $C_6H_5CH_2^-$
(a) I > II > III > IV (b) IV > III > II > I
(c) IV > I > II > III (d) I > II > IV > III

22. Under two different conditions an element could be made to exist in *bcc* and *fcc* arrangements with exactly same interatomic distance. The ratio of the densities in the two forms is

(a) 1 : 1 (b) 0.919 : 1

(c) 1 : 0.919 (d) 0.2 : 1

23. Which one of the following sequences represents the correct increasing order of bond angles in the given molecules?

(a) $H_2O < OF_2 < OCl_2 < ClO_2$

(b) $OCl_2 < ClO_2 < H_2O < OF_2$

(c) $OF_2 < H_2O < OCl_2 < ClO_2$

(d) $ClO_2 < OF_2 < OCl_2 < H_2O$

24. In the keto-enol tautomerism of dicarbonyl compounds, the enol form is preferred in contrast to the keto form, this is due to

(a) presence of carbonyl group on each side of $-CH_2-$

(b) H-bonding and resonance stabilisation of enol form

(c) presence of methylene group

(d) rapid chemical exchange.

25. From the following equations, what is the heat of a hypothetical reaction, $P \longrightarrow 2Q$?

(i) $P \longrightarrow R; \Delta H_1 = x$

(ii) $R \longrightarrow S; \Delta H_2 = y$

(iii) $\frac{1}{2} S \longrightarrow Q; \Delta H_3 = z$

(a) $x + y - 2z$ (b) $x + 2y - 2z$

(c) $x + y + 2z$ (d) $x - y + 2z$

26. Titanium shows magnetic moment of 1.73 B.M. in its compound. What is the oxidation number of Ti in this compound?

(a) +1 (b) +4

(c) +3 (d) +2

27. For the estimation of nitrogen, 1.4 g of an organic compound was digested by Kjeldahl's method and the evolved ammonia was absorbed in 60 mL of $\frac{M}{10}$ sulphuric acid. The unreacted acid required 20 mL of $\frac{M}{10}$ sodium hydroxide for complete neutralisation. The percentage of nitrogen in the compound is

(a) 5% (b) 6%

(c) 10% (d) 3%

28. Propan-1-ol can be prepared from propene by

(a) H_2O/H_2SO_4

(b) $Hg(OAc)_2/H_2O$ followed by $NaBH_4$

(c) B_2H_6 followed by H_2O_2

(d) Br_2/H_2O

29. Which of the following sets is named as ferrous metals?

(a) Fe, Ru, Os (b) Fe, Co, Ni

(c) Fe, Mn, Cr (d) Fe, Rh, Pt

30. Which one of the following is the correct statement?

(a) $B_2H_6 \cdot 2NH_3$ is known as 'inorganic benzene'.

(b) Boric acid is a protonic acid.

(c) Beryllium exhibits coordination number of six.

(d) Chlorides of both beryllium and aluminium have bridged chloride structures in solid phase.

31. What is the pH of the x M NaOH solution if its 100 mL is completely neutralised by 10 mL of 0.1 M HCl?

(a) 2 (b) 5

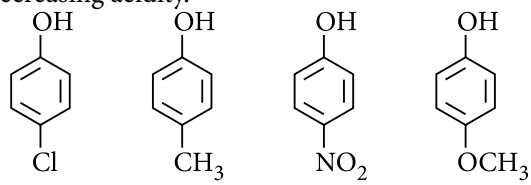
(c) 10 (d) 12

32. Which of the following will give maximum number of isomers?

(a) $[Co(NH_3)_4Cl_2]$ (b) $[Ni(en)(NH_3)_4]^{2+}$

(c) $[Ni(C_2O_4)(en)_2]$ (d) $[Cr(SCN)_2(NH_3)_4]^{2+}$

33. Arrange the following compounds in order of decreasing acidity.



(I) (II) (III) (IV)

(a) IV > III > I > II (b) II > IV > I > III

(c) I > II > III > IV (d) III > I > II > IV

34. The radioactive isotope $^{60}_{27}Co$ which is used in the treatment of cancer can be made by (n, p) reaction. For this reaction the target nucleus is

(a) $^{60}_{27}Co$ (b) $^{59}_{28}Ni$

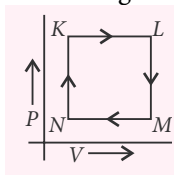
(c) $^{59}_{27}Co$ (d) $^{60}_{28}Ni$

35. An organic compound with the formula $C_6H_{12}O_6$ forms a yellow crystalline solid with phenylhydrazine and gives a mixture of sorbitol and mannitol when reduced with sodium. Which among the following could be the compound?

(a) Fructose (b) Glucose

(c) Mannose (d) Sucrose

36. A fixed mass of a gas is subjected to transformations of state from K to L to M to N and back to K as shown. The pair of isochoric processes among the transformations of state is



(a) K to L and L to M
(b) L to M and N to K
(c) L to M and M to N
(d) M to N and N to K

37. Which of the following bonds has highest energy?
(a) Se—Se (b) Te—Te
(c) S—S (d) O—O

38. Which one of the following is not correctly matched?

(a) $>C=O \xrightarrow{\text{Clemmensen reduction}} >CH_2$

(b) $>C=O \xrightarrow{\text{Wolff–Kishner reduction}} >CHOH$

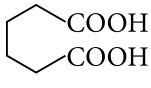
(c) $-COCl \xrightarrow{\text{Rosenmund reduction}} -CHO$

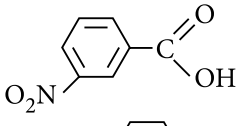
(d) $-C\equiv N \xrightarrow{\text{Stephen reduction}} -CHO$

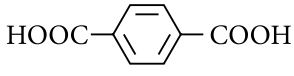
39. If the volume of the container is decreased to $\frac{1}{3}$rd of the original volume, by how much will the rate change for the reaction, $2NO + O_2 \longrightarrow 2NO_2$?
(a) 9 times increase (b) 9 times decrease
(c) 27 times increase (d) 27 times decrease

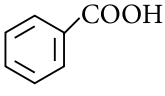
40. What is 'Z' in the following sequence of reactions?

$$O_2N\text{-}C_6H_4\text{-}Br \xrightarrow{Mg/ether} (X) \xrightarrow[(dry\ ice)]{CO_2} (Y) \xrightarrow{H_3O^+} (Z)$$

(a) 

(b) 

(c) 

(d) 

SOLUTIONS

1. **(a) :** All these species are isoelectronic (14 electrons) and have B.O. three.

2. **(c) :** Polyphosphates like sodium hexametaphosphate [calgon, $(NaPO_3)_6$] form soluble complexes with cationic species like Ca^{2+} and Mg^{2+} present in hard water.

3. **(a) :** Structures I and II differ only in the position of OH at C–1 and hence are anomers.

4. **(c) :** $n = 3, l = 0$ represents $3s$ orbital.
$n = 3, l = 1$ represents $3p$ orbital.
$n = 3, l = 2$ represents $3d$ orbital.
$n = 4, l = 0$ represents $4s$ orbital.
The order of increasing energy of the orbitals is :
$3s < 3p < 4s < 3d$

5. **(a) :** At anode : $Cl^- \longrightarrow \frac{1}{2}Cl_2 + e^-$

At cathode : $\frac{1}{2}Cl_2 + e^- \longrightarrow Cl^-$

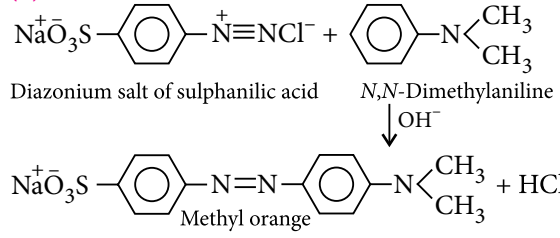
$[Cl^-]$ at anode $= x$ M
At cathode, $[Ag^+][Cl^-] = K_{sp}$

$\Rightarrow \quad [Cl^-] = \sqrt{K_{sp}} \qquad (\because [Ag^+] = [Cl^-])$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{n}\log\frac{[Cl^-]_{cathode}}{[Cl^-]_{anode}}$$

$$= 0 - \frac{0.059}{1}\log\frac{\sqrt{K_{sp}}}{x} = +0.059\log\frac{x}{\sqrt{K_{sp}}}$$

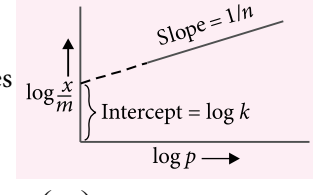
6. **(b) :**



7. **(c) :** $\frac{x}{m} = kp^{1/n}$

Taking log on both sides

$$\log\frac{x}{m} = \log k + \frac{1}{n}\log p$$



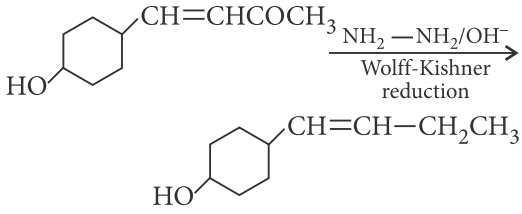
Thus, a graph between $\log\left(\frac{x}{m}\right)$ and $\log p$, will give a straight line of slope $= 1/n$ and intercept $= \log k$.

8. **(a) :** A dilute solution of sodium thiosulphate ($Na_2S_2O_3$) when treated with $AgNO_3$ solution, first gives a white ppt. of silver thiosulphate ($Ag_2S_2O_3$) which readily changes to yellow, orange, brown and finally black due to formation of silver sulphide, Ag_2S.

$$2AgNO_3 + Na_2S_2O_3 \longrightarrow \underset{\text{white ppt.}}{Ag_2S_2O_3\downarrow} + 2NaNO_3$$

$$Ag_2S_2O_3 + H_2O \longrightarrow \underset{\text{black ppt.}}{Ag_2S\downarrow} + H_2SO_4$$

9. (d) :



—OH and $\rangle C{=}C\langle$ groups are acid sensitive groups so, Clemmensen reduction (Zn–Hg/HCl) cannot be used and $NaBH_4$ reduces $\rangle C{=}O$ to —CHOH.

Birch reduction (Na/liq. NH_3) reduces alkynes to predominantly *trans*-alkene.

10. (d) : Alkaline earth metals are Group 2 elements. Emission of α-particle (^4_2He) will reduce its atomic number by 2 units and thus, displaces the daughter nuclei two positions left in the periodic table, thus to group 18, 16, 14, 12, 10, 8, 6 or 4, etc. As the last stable daughter nuclei formed could be either Pb (Group 14) or Bi (Group 15) therefore, the daughter nuclei would belong to Group 14.

11. (b) : Elastomers or rubbers have the weakest intermolecular forces of attraction followed by thermoplastics while fibres have the strongest forces of attraction. Thus, the increasing order of intermolecular forces of attraction is : Elastomer < Thermoplastic < Fibre, *i.e.*,
Buna-S < Polythene < Nylon-6,6

12. (d) : For '*n*' moles of gas, van der Waals' equation is :

$$\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$$

For 0.2 mol, $\left(P+\frac{0.04a}{V^2}\right)(V-0.2b)=0.2RT$

13. (c) : Electronegativity increases from left to right in a period and decreases from top to bottom in a group. Hence, electronegativity of the given elements follows the order: Si < P < C < N.

14. (b) : It contains only four π-electrons and thus, it does not obey Huckel's rule. Due to presence of sp^3-hybridised carbon atom, the system is not planar. Therefore, it is not aromatic.

15. (d) : $N_2 + 3H_2 \rightleftharpoons 2NH_3$; K_1

$$\Rightarrow \quad 2NH_3 \rightleftharpoons N_2 + 3H_2;\ K' = \frac{1}{K_1} \qquad \ldots(i)$$

$$N_2 + O_2 \rightleftharpoons 2NO;\ K_2 \qquad \ldots(ii)$$

$$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O;\ K_3$$

$$\Rightarrow \quad 3H_2 + \frac{3}{2}O_2 \rightleftharpoons 3H_2O;\ K'' = K_3^3 \qquad \ldots(iii)$$

Adding eqns. (i), (ii) and (iii), we get

$$2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O;\ K = ?$$

$$K = K' \times K_2 \times K'' = \frac{K_2 \cdot K_3^3}{K_1}$$

16. (b) : In $Na_2[CdCl_4]$; Oxidation state of Cd = +2

$$Cd^{2+} : 4d^{10}$$

Since Cd^{2+} has fully filled *d*-orbital, *d-d* transition is not possible and hence, compound is colourless.

17. (c) : Oxygen gas does not contribute to greenhouse effect.

18. (a) : Structure (a) is enantiomer of molecule (*A*) because in this, the configuration of two groups, *i.e.*, CH_3 and C_2H_5 is reversed at the chiral carbon.

19. (d) : $\lambda = \dfrac{h}{\sqrt{2m(KE)}}$

$$\frac{\lambda_{He}}{\lambda_{Ne}} = \sqrt{\frac{m_{Ne}(KE)_{Ne}}{m_{He}(KE)_{He}}} \qquad \ldots(i)$$

$$\Rightarrow \quad \frac{m_{Ne}}{m_{He}} = \frac{20}{4} = 5 \qquad \ldots(ii)$$

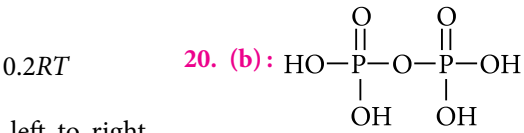
$$KE \propto T$$

$$\frac{(KE)_{Ne}}{(KE)_{He}} = \frac{727+273}{-73+273} = \frac{1000}{200} = 5 \qquad \ldots(iii)$$

Put values from eqns. (ii) and (iii) in eqn. (i)

$$\frac{\lambda_{He}}{\lambda_{Ne}} = \sqrt{5\times 5} = 5$$

20. (b) :



Pyrophosphoric acid, $H_4P_2O_7$ has four hydroxyl groups and hence is tetrabasic in nature.

21. (b) : Order of stability of carbanions is 1° > 2° > 3°, but $C_6H_5CH_2^-$ is most stable due to resonance stabilisation. Thus, order of stability is :

$$\underset{(IV)}{C_6H_5CH_2^-} > \underset{(III)}{CH_3CH_2^-} > \underset{(II)}{(CH_3)_2CH^-} > \underset{(I)}{(CH_3)_3C^-}$$

22. (b) : For *bcc*, $4r = \sqrt{3}\,a_1$ and $Z_1 = 2$

For *fcc*, $4r = \sqrt{2}\,a_2$ and $Z_2 = 4$

For equal interatomic distance,

$$\sqrt{3}\,a_1 = \sqrt{2}\,a_2$$

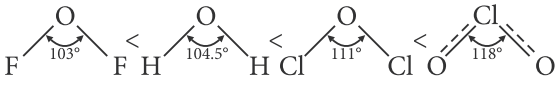
$$\frac{a_2}{a_1} = \frac{\sqrt{3}}{\sqrt{2}}$$

$$\frac{d_1}{d_2} = \frac{\frac{MZ_1}{a_1^3 N_0}}{\frac{MZ_2}{a_2^3 N_0}} = \frac{a_2^3 Z_1}{a_1^3 Z_2}$$

$$= \left(\sqrt{\frac{3}{2}}\right)^3 \times \frac{2}{4} = \frac{\left(\sqrt{1.5}\right)^3}{2}$$

$$= \frac{1.5 \times \sqrt{1.5}}{2} = \frac{1.5 \times 1.225}{2} = \frac{0.919}{1} = 0.919 : 1$$

23. (c) : H_2O is sp^3 hybridised with bond angle 104.5° due to presence of two lone pairs. OF_2 has structure similar to H_2O with bond angle 103° due to higher electronegativity of fluorine. OCl_2 also has similar structure with bond angle 111° because of steric crowding of two chlorine atoms. However, ClO_2 has π-bond character with an odd electron so that bond angle is 118°. Thus, four compounds can be arranged in order of their bond angles as



24. (b) : H-bonding and resonance stabilisation of enol form make it more stable.

25. (c) : ΔH for $P \longrightarrow 2Q$ is obtained using Hess's law, by adding eqn. (i), eqn. (ii) and 2 × eqn. (iii); $\Delta H = x + y + 2z$.

26. (c) : Magnetic moment = $\sqrt{n(n+2)}$ B.M.

$$\sqrt{n(n+2)} = 1.73 \text{ B.M.}$$

$$\Rightarrow \quad n(n+2) = (1.73)^2$$

$$n(n+2) = 3$$

$$\therefore \quad n = 1$$

It means Ti has one unpaired electron *i.e.* its electronic configuration is $3d^1$ which refers to Ti^{3+}.

27. (c) : Mass of an organic compound = 1.4 g

$$\% \text{ of N} = \frac{1.4 \times \text{Meq. of acid consumed}}{\text{Mass of compound taken}}$$

$$\text{Meq. of acid consumed} = \left(60 \times \frac{1}{10} \times 2\right) - \left(20 \times \frac{1}{10} \times 1\right)$$

$$= 10 \quad [\text{Basicity of acid} = 2]$$

$$\% \text{ of N} = \frac{1.4 \times 10}{1.4} = 10\%$$

28. (c) : Hydroboration-oxidation gives anti - Markownikoff's product.

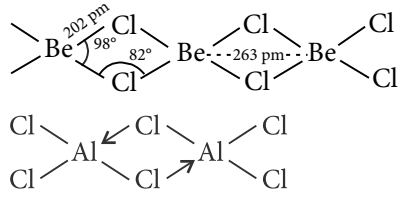
$$\underset{\text{Propene}}{CH_3-CH=CH_2} \xrightarrow[(ii)\ H_2O_2/OH^-]{(i)\ B_2H_6} \underset{\text{Propan-1-ol}}{CH_3-CH_2-CH_2OH}$$

29. (b) : Fe, Co and Ni are called ferrous metals.

30. (d) : Boric acid is a weak monobasic acid ($K_a = 1.0 \times 10^{-9}$). Boric acid does not act as a protonic acid (*i.e.*, proton donor) but behaves as a Lewis acid by accepting a pair of electrons from OH^- ion of water thereby releasing a proton.

$$B(OH)_3 + 2H_2O \longrightarrow [B(OH)_4]^- + H_3O^+$$

$BeCl_2$ like Al_2Cl_6 has a bridged chloride structure in solid phase.



Beryllium exhibits coordination number of four as it has only four available orbitals in its valence shell.

Also, $3B_2H_6 + 6NH_3 \longrightarrow 3[BH_2(NH_3)_2]^+[BH_4]^-$

or

$$B_2H_6 \cdot 2NH_3 \xrightarrow{\text{Heat, 450 K}} \underset{\text{Borazine}}{2B_3N_3H_6} + 12H_2$$

Borazine has structure similar to benzene and therefore, it is called inorganic benzene.

31. (d) : x M NaOH = x N NaOH

0.1 M HCl = 0.1 N HCl

$100 \times x(\text{NaOH}) = 10 \times 0.1(\text{HCl})$

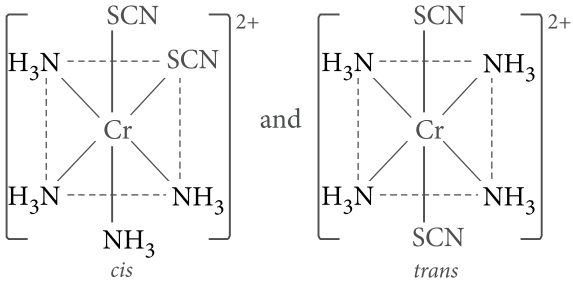
$$x = \frac{1}{100}$$

$$[OH^-] = x = 10^{-2}$$

$$\text{pOH} = 2$$

Hence, $\text{pH} = 14 - 2 = 12$

32. (d) : $[Cr(SCN)_2(NH_3)_4]^{2+}$ shows geometrical and linkage isomerism.



cis *trans*

$[Cr(SCN)_2(NH_3)_4]^{2+}$ and $[Cr(NCS)_2(NH_3)_4]^{2+}$ are linkage isomers. *cis*- and *trans*-forms are possible for both linkage isomers.

33. (d) : Electron donating groups ($-CH_3$ and $-OCH_3$) decrease while electron withdrawing groups ($-NO_2$ and $-Cl$) increase the acidity.

Since $-OCH_3$ is a stronger electron donating group than $-CH_3$ and $-NO_2$ is stronger electron withdrawing group than $-Cl$, therefore, order of decreasing acidity is III > I > II > IV.

34. (d) : Let the target nucleus be ${}^{A}_{Z}X$

Then, ${}^{A}_{Z}X + {}^{1}_{0}n \rightarrow {}^{60}_{27}Co + {}^{1}_{1}H$

Equating atomic numbers on both sides,

$Z + 0 = 27 + 1$

$\Rightarrow \quad Z = 28$

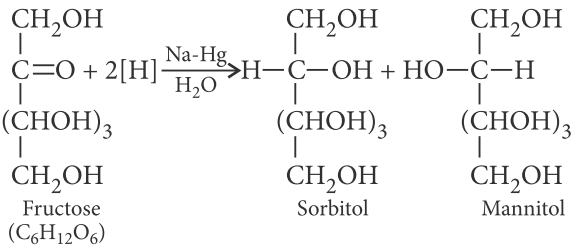
Equating mass numbers on both sides,

$A + 1 = 60 + 1$

$\Rightarrow \quad A = 60$

Thus, ${}^{A}_{Z}X = {}^{60}_{28}Ni$

35. (a) : Fructose undergoes osazone formation with phenylhydrazine. However, on partial reduction with sodium amalgam and water, a mixture of two epimeric alcohols, sorbitol and mannitol is obtained. This is due to the creation of a new asymmetric carbon atom at C-2.



36. (b) : For transformations $L \rightarrow M$ and $N \rightarrow K$, volume is constant.

37. (c) : The strength of element—element bond decreases down the group as the size of the atom increases. O—O bond is weaker than S—S bond because of strong interelectronic repulsions due to small size of oxygen atom.

38. (b) : $>C=O \xrightarrow{\text{Wolff–Kishner reduction}} >CH_2$

39. (c) : $r = k[NO]^2[O_2]$

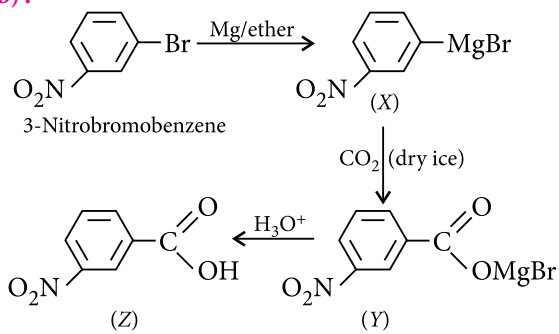
Decreasing volume to $\frac{1}{3}$rd will increase the concentration to 3 times.

$r' = k[3NO]^2\,[3O_2]$

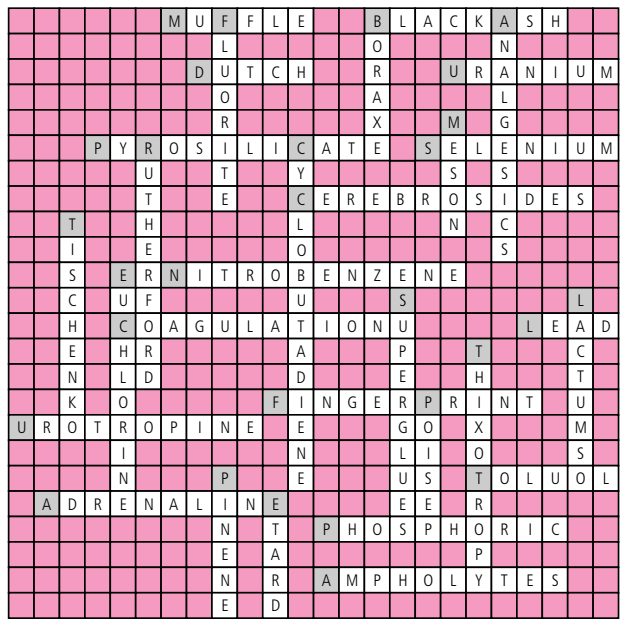
$$\frac{r'}{r} = \frac{k[3NO]^2[3O_2]}{k[NO]^2[O_2]} = (3)^2(3) = 27$$

Rate will increase 27 times.

40. (b) :



SOLUTIONS TO MARCH 2015 CROSSWORD



Winners of March 2015 Crossword

Renuka Maheshwari, Bikaner (Rajasthan)

Sunil Sharma (Maharashtra)

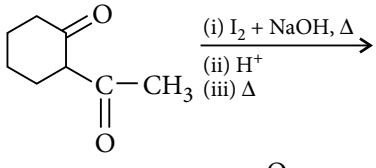
OLYMPIAD PROBLEMS

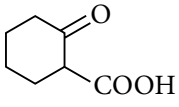
1. Which of the following cycloalkanes has the greatest angle strain?
   (a) Cyclopropane (b) Methyl cyclopentane
   (c) Cyclobutane (d) Cyclopentane

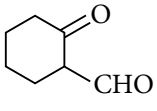
2. When a certain metal was irradiated with light of frequency 3.2×10^{16} Hz, photoelectrons emitted had twice the kinetic energy as did photoelectrons emitted when the same metal was irradiated with light of frequency 2.0×10^{16} Hz. Hence, threshold frequency is
   (a) 0.8×10^{15} Hz (b) 8.0×10^{15} Hz
   (c) 0.8×10^{14} Hz (d) 6.4×10^{16} Hz

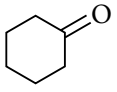
3. At 300°C, $FeCl_3$
   (a) decomposes into $FeCl_2$ and Cl_2
   (b) decomposes into Fe and Cl_2
   (c) sublimes to give liquid $FeCl_3$
   (d) sublimes to give gaseous dimer $(FeCl_3)_2$.

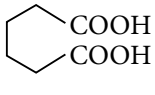
4. End products of the following sequence of reactions are



   (a) yellow ppt. of CHI_3, 

   (b) yellow ppt. of CHI_3, 

   (c) yellow ppt. of CHI_3, 

   (d) yellow ppt. of CHI_3, 

5. The compressibility factor of a gas is less than unity at STP. Therefore,
   (a) $V_m > 22.4$ L (b) $V_m < 22.4$ L
   (c) $V_m = 22.4$ L (d) $V_m = 44.8$ L

6. Three elements *X*, *Y* and *Z* have atomic numbers 19, 37 and 55 respectively. Then, the correct statement is
   (a) their ionisation potential would increase with increasing atomic numbers
   (b) *Y* would have an ionisation potential between those of *X* and *Z*
   (c) *Y* would have the highest ionisation potential
   (d) *Z* would have the highest ionisation potential.

7. Which of the following species is the conjugate acid of the hemiacetal formed by reaction of benzaldehyde with methanol containing a trace of acid?

   (a) $C_6H_5HC(OH)(OCH_3)$ (b) $C_6H_5CH{=}\overset{+}{O}CH_3$

   (c) $C_6H_5HC(OH)(\overset{+}{O}HCH_3)$ (d) $C_6H_5HC(OH)(\overset{+}{O}H_2)$

8. 100 mL of 0.1 M HCl is titrated with 0.1 M NaOH. The pH of the reaction mixture after the addition of 50 mL, 100 mL and 150 mL of NaOH respectively are
   (a) 1.3, 7.0, 9.23 (b) 1.48, 7.0, 12.3
   (c) 1.48, 7.0, 1.7 (d) 7.0, 1.3, 12.3

9. Allyl cyanide has
   (a) 9 sigma bonds and 4 pi bonds
   (b) 9 sigma bonds, 3 pi bonds and 1 lone pair
   (c) 8 sigma bonds and 5 pi ponds
   (d) 8 sigma bonds, 3 pi bonds.

10. The alkene, $R{-}CH{=}CH_2$ reacts readily with B_2H_6 and the product on oxidation with alkaline hydrogen peroxide produces

(a) $R-CH_2-CHO$ (b) $R-CH_2-CH_2-OH$

(c) $R-\underset{\underset{CH_3}{|}}{C}=O$ (d) $R-\underset{\underset{OH}{|}}{CH}-\underset{\underset{OH}{|}}{CH_2}$

11. The enthalpy of neutralization of a strong acid by a strong base is –57.32 kJ mol^{-1}. The enthalpy of formation of water is –285.84 kJ mol^{-1}. The enthalpy of formation of the hydroxyl ion is

(a) +228.52 kJ mol^{-1} (b) –114.26 kJ mol^{-1}

(c) –228.52 kJ mol^{-1} (d) +114.26 kJ mol^{-1}

12. Select the incorrect statement.

(a) Li_2CO_3 is only sparingly soluble in water and no $LiHCO_3$ has been isolated.

(b) K_2CO_3 cannot be made by a method similar to the ammonia-soda process.

(c) Li_2CO_3 and $MgCO_3$ both are thermally stable.

(d) $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$ is a mineral called trona.

13. 2-Pentanone is reacted with $NaBH_4$ followed by hydrolysis with D_2O the product will be

(a) $CH_3CH(OD)CH_2CH_2CH_3$

(b) $CH_3CD(OH)CH_2CH_2CH_3$

(c) $CH_3CH(OH)CH_2CH_2CH_3$

(d) $CH_3CD(OD)CH_2CH_2CH_3$

14. Which substance participates readily in both acid-base and oxidation-reduction reactions?

(a) Na_2CO_3 (b) KOH

(c) $KMnO_4$ (d) $H_2C_2O_4$

15. Which of the following orthosilicates is known as willemite?

(a) $Zn_3[SiO_4]_2$ (b) $Mn_2[SiO_4]$

(c) $W_2[SiO_4]$ (d) $Zn_2[SiO_4]$

16. How many toluene derivatives have the formula C_7H_7Cl?

(a) 1 (b) 2

(c) 3 (d) 4

17. A complex is represented as $CoCl_3.xNH_3$. Its 0.1 m aqueous solution shows $\Delta T_f = 0.558$ °C. If coordination number of Co (III) is 6, what is the formula of complex?

[$K_f(H_2O)$ = 1.86 K kg mol^{-1} and assume 100% ionization]

(a) $[Co(NH_3)_5Cl]Cl_2$ (b) $[Co(NH_3)_4Cl_2]Cl$

(c) $[Co(NH_3)_6]Cl_3$ (d) None of these

18. NH_3 forms complex ion $[Cu(NH_3)_4]^{2+}$ with Cu^{2+} ion in alkaline solution but not in acidic solution. This is due to the reason that

(a) in acidic solution hydration protects Cu^{2+} ions.

(b) in acidic solution proton coordinates with ammonia molecules forming NH_4^+ ions.

(c) in alkaline solution $Cu(OH)_2$ is precipitated which is soluble in excess of NH_3.

(d) $Cu(OH)_2$ is amphoteric in nature.

19. α-amino acid may be prepared by

(a) Williamson synthesis

(b) Skraup synthesis

(c) Strecker synthesis

(d) Knorr synthesis

20. The hexa-aqua iron(III) ion hydrolyses as shown below :

$[Fe(H_2O)_6]^{3+} + H_2O \rightarrow [Fe(H_2O)_5OH]^{2+} + H_3O^+$

Which of the following statements is correct?

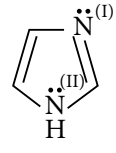
(a) The hydrolysis is favoured by low pH value.

(b) The iron undergoes a change in oxidation state.

(c) The corresponding iron (III) ion in $[Fe(H_2O)_5OH]^{2+}$ is less likely to undergo hydrolysis.

(d) The hydrolysis is highly favoured at high temperature.

21. Pick up the correct statement regarding imidazole.



(a) It is an aromatic compound and both lone pairs of electrons on N are delocalised.

(b) Lone pair marked (I) undergoes protonation more readily than the lone pair marked (II).

(c) Lone pair marked (II) is protonated more readily than the lone pair marked (I).

(d) Both lone pairs are protonated easily.

22. Which of the following metals is sensitive to a wide range of photons from across the entire visible range of the electromagnetic spectrum?

(a) Li (b) Na (c) Cs (d) Sr

23. Which of the following nuclear processes are identical?

(a) β^+ emission and β^- emission

(b) α emission and γ radiation

(c) β^+ emission and electron capture

(d) γ radiation and production of X-rays

24. Hausmannite is the ore of
(a) mercury (b) manganese
(c) nickel (d) zinc

25. Which is true about the acidic character of hydroxyl groups of sugars and hydroxyl group of an alcohol?
(a) The OH's of sugars are more acidic than that of a typical alcohol.
(b) The OH's of sugars are less acidic than that of a typical alcohol.
(c) Both have similar acidic character.
(d) The OH's of sugars are neutral while that of an alcohol is acidic.

26. The activation energies of two reactions are E_a and E'_a, $E_a > E'_a$. If the temperature of reacting systems is increased from T_1 to T_2, predict which of the following alternatives is correct?(k_1, k'_1 are the rate constants at T_1 and k_2, k'_2 are the rate constants at T_2)
(a) $\frac{k'_1}{k_1} = \frac{k'_2}{k_2}$ (b) $\frac{k'_1}{k_1} < \frac{k'_2}{k_2}$
(c) $\frac{k'_1}{k_1} > \frac{k'_2}{k_2}$ (d) $\frac{k'_1}{k_1} = 2\frac{k'_2}{k_2}$

27. The strongest reducing agent amongst the following is
(a) $P_2O_7^{4-}$ (b) $P_2O_6^{4-}$
(c) H_3PO_4 (d) $H_2PO_2^-$

28. Hard plastic covers of telephones are made of polymer of
(a) methyl methacrylate
(b) vinyl acetate
(c) neoprene
(d) phenol and formaldehyde.

29. When a little NaOH solution is added to a freshly obtained SnO_2 precipitate suspended in water,
(a) a true solution is obtained
(b) a positively charged sol is obtained due to preferential absorption of Na^+ ions by precipitate particles
(c) a negatively charged sol is obtained due to preferential adsorption of OH^- ions
(d) a negatively charged sol is obtained due to preferential adsorption of SnO_3^{2-} ions.

30. Which of the following statements about the oxidising property of $KMnO_4$ in acidic medium is not correct?
(a) H_2S is oxidised to SO_4^{2-}
(b) H_2S is oxidised to S
(c) SO_3^{2-} gets oxidised to SO_4^{2-}
(d) $C_2O_4^{2-}$ gets oxidised to CO_2

ANSWER KEYS

1.	(a)	2.	(b)	3.	(d)	4.	(c)	5.	(b)
6.	(b)	7.	(c)	8.	(b)	9.	(b)	10.	(b)
11.	(c)	12.	(c)	13.	(a)	14.	(d)	15.	(d)
16.	(d)	17.	(a)	18.	(b)	19.	(c)	20.	(d)
21.	(b)	22.	(c)	23.	(c)	24.	(b)	25.	(a)
26.	(c)	27.	(d)	28.	(d)	29.	(d)	30.	(a)

Exam on : 3rd May

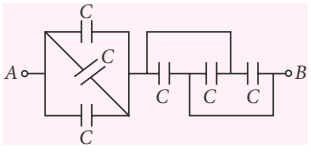
Target AIPMT

Full Length Practice Paper

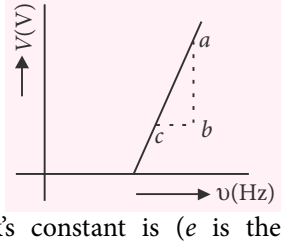
PHYSICS

1. In certain Young's double slit experiment, the slit separation is 0.05 cm. The slit to screen distance is 100 cm. When blue light is used, the distance from central fringe to the fourth order bright fringe is 0.36 cm. What is the wavelength of blue light ?
   (a) 4000 Å (b) 4300 Å
   (c) 4400 Å (d) 4500 Å

2. In the given figure, the equivalent capacitance between points A and B is
   (a) $1.5C$
   (b) $2C$
   (c) $3C$
   (d) $6C$



3. In a photoelectric experiment, the graph of frequency υ of incident light (in Hz) and stopping potential V (in V) is as shown in the figure. From figure, the value of the Planck's constant is (e is the elementary charge)

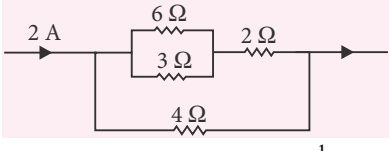


   (a) $e\frac{ab}{cb}$ (b) $e\frac{cb}{ab}$ (c) $e\frac{ac}{bc}$ (d) $e\frac{ac}{ab}$

4. When an electron jumps from the fourth orbit to the second orbit, one gets the
   (a) second line of Paschen series
   (b) second line of Balmer series
   (c) first line of Pfund series
   (d) second line of Lyman series

5. In the following equation, x, t and F represent respectively, displacement, time and force :
   $$F = a + bt + \frac{1}{c + d \cdot x} + A\sin(\omega t + \phi)$$
   The dimensional formula for $A \cdot d$ is
   (a) $[T^{-1}]$ (b) $[L^{-1}]$ (c) $[M^{-1}]$ (d) $[TL^{-1}]$

6. In the circuit shown in figure, the potential difference across 3 Ω is
   (a) 2 V
   (b) 4 V
   (c) 8 V
   (d) 16 V



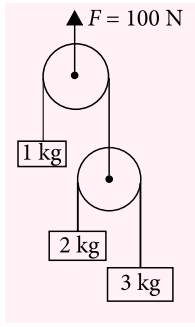
7. The critical angle of a certain medium is $\sin^{-1}(3/5)$. The polarising angle of the medium is
   (a) $\sin^{-1}\left(\frac{4}{5}\right)$ (b) $\tan^{-1}\left(\frac{5}{3}\right)$
   (c) $\tan^{-1}\left(\frac{3}{4}\right)$ (d) $\tan^{-1}\left(\frac{4}{3}\right)$

8. There is some change in length when a 33000 N tensile force is applied on a steel rod of area of cross-section 10^{-3} m^2. The change in temperature required to produce the same elongation if the steel rod is heated is
   (The modulus of elasticity is 3×10^{11} N m^{-2} and coefficient of linear expansion of steel is 1.1×10^{-5} $°C^{-1}$)
   (a) 20°C (b) 15°C (c) 10°C (d) 0°C

9. Which of the following types of electromagnetic radiation travels at the greatest speed in vacuum?
   (a) Radio waves
   (b) Visible light
   (c) X-rays
   (d) All of these travel at the same speed

10. A particle moving along the x axis has position given by $x = (24t - 2.0t^3)$ m, where t is measured in s. What is the magnitude of the acceleration of the particle at the instant when its velocity is zero?
    (a) 24 m s^{-2} (b) zero
    (c) 12 m s^{-2} (d) 48 m s^{-2}

11. In the diagram shown in figure, both pulleys and strings are massless. The acceleration of 2 kg block is



(a) 2.5 m s^{-2} (↑)
(b) 5 m s^{-2} (↑)
(c) 7.5 m s^{-2} (↓)
(d) 10 m s^{-2} (↑)

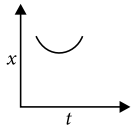
12. The power and type of lens by which a person can see clearly the distant objects, if the person cannot see objects beyond 40 cm, are
(a) –2.5 D and concave lens
(b) –2.5 D and convex lens
(c) –3.5 D and concave lens
(d) –3.5 D and convex lens

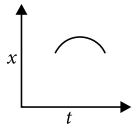
13. A reactor is developing energy at the rate of 3000 kW. How many atoms of U^{235} undergo fission per second, if 200 MeV energy is released per fission?
(a) 6.5×10^{22} (b) 5.15×10^{21}
(c) 3.384×10^{23} (d) 9.4×10^{16}

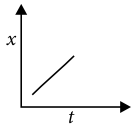
14. An object of mass 0.2 kg executes simple harmonic motion along x-axis with frequency of $(25/\pi)$ Hz. At the position $x = 0.04$ m, the object has a kinetic energy of 0.5 J and potential energy of 0.4 J. The amplitude of oscillation is equal to
(a) 0.05 m (b) 0.06 m
(c) 0.01 m (d) 0.02 m

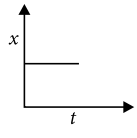
15. When the angle of projection is 75°, a ball falls 10 m short of the target. When the angle of projection is 45°, it falls 10 m ahead of the target. Both are projected from the same point with the same speed in the same direction, the distance of the target from the point of projection is
(a) 15 m (b) 30 m (c) 45 m (d) 10 m

16. Position-time graph for motion with negative acceleration is

(a) 

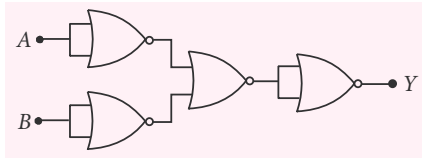
(b) 

(c) 

(d) 

17. The maximum energy in the thermal radiation from a hot source occurs at a wavelength of 11×10^{-5} cm. According to Wien's law, the temperature of the source (on Kelvin scale) will be n times the temperature of another source (on Kelvin scale) for which the wavelength at maximum energy is 5.5×10^{-5} cm. The value of n is
(a) 2 (b) 4 (c) $\frac{1}{2}$ (d) 1

18. The circuit as shown in the figure is equivalent to



(a) AND gate (b) NOR gate
(c) OR gate (d) NAND gate

19. A particle is moving three times as fast as an electron. The ratio of the de Broglie wavelength of the particle to that of the electron is 1.813×10^{-4}. The mass of the particle is
(Mass of electron = 9.1×10^{-31} kg)
(a) 1.67×10^{-27} kg (b) 1.67×10^{-31} kg
(c) 1.67×10^{-30} kg (d) 1.67×10^{-32} kg

20. A coin placed on a rotating table just slips if it is placed at a distance $4r$ from the centre. On doubling the angular velocity of the table, the coin will just slip when at a distance from the centre equal to
(a) $4r$ (b) $2r$ (c) r (d) $\frac{r}{4}$

21. The refractive index of water with respect to air is 4/3 and the refractive index of glass with respect to air is 3/2. Then the refractive index of water with respect to glass is
(a) $\frac{9}{8}$ (b) $\frac{8}{9}$ (c) $\frac{1}{2}$ (d) 2

22. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t the maximum velocity acquired by the car is
(a) $\frac{(\alpha^2+\beta^2)t}{\alpha\beta}$ (b) $\frac{\alpha\beta}{t(\alpha+\beta)}$
(c) $\frac{\alpha\beta t}{(\alpha+\beta)}$ (d) $\frac{(\alpha+\beta)t}{\alpha\beta}$

23. Two conducting spheres of radii 3 cm and 1 cm are separated by a distance of 10 cm in free space. If the spheres are charged to same potential of 10 V each, the force of repulsion between them is
(a) $\left(\frac{1}{3}\right)\times 10^{-9}$ N (b) $\left(\frac{2}{9}\right)\times 10^{-9}$ N
(c) $\left(\frac{1}{9}\right)\times 10^{-9}$ N (d) $\left(\frac{4}{3}\right)\times 10^{-9}$ N

24. A mass of 10 kg is suspended from a spring balance. It is pulled a side by a horizontal string so that it makes an angle of 60° with the vertical. The new reading of the balance is

(a) 20 kg wt (b) 10 kg wt

(c) $10\sqrt{3}$ kg wt (d) $20\sqrt{3}$ kg wt

25. A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring, so that the spring is compressed by a distance d. The net work done in the process is

(a) $mg(h+d)+\frac{1}{2}kd^2$ (b) $mg(h+d)-\frac{1}{2}kd^2$

(c) $mg(h-d)-\frac{1}{2}kd^2$ (d) $mg(h-d)+\frac{1}{2}kd^2$

26. Light of wavelength 0.6 μm from a sodium lamp falls on a photocell and causes the emission of photoelectrons for which the stopping potential is 0.5 V. With light of wavelength 0.4 μm from a sodium lamp, stopping potential is 1.5 V. With this data, the value of h/e is

(a) 4×10^{-19} V s (b) 0.25×10^{15} V s

(c) 4×10^{-15} V s (d) 4×10^{-8} V s

27. A microscope is focussed on a mark on a paper and then a slab of glass of thickness 3 cm and refractive index 1.5 is placed over the mark. How should the microscope be moved to get the mark in focus again?

(a) 2 cm upward (b) 1 cm upward

(c) 4.5 cm upward (d) 1 cm downward

28. A garden hose having an internal diameter 2.0 cm is connected to a lawn sprinkler that consists of an enclosure with 24 holes, each 0.125 cm in diameter. If water in the hose has a speed of 90.0 cm s^{-1}, find the speed of the water having the sprinkler hole.

(a) 860 cm s^{-1} (b) 960 cm s^{-1}

(c) 760 cm s^{-1} (d) 660 cm s^{-1}

29. The current gain of a transistor is 0.9. The transistor is connected in common base configuration. What would be the change in collector current when base current changes by 4 mA?

(a) 1.2 mA (b) 12 mA (c) 24 mA (d) 36 mA

30. An object placed in front of a concave mirror at a distance of x cm from the pole gives a 3 times magnified real image. If it is moved to a distance of $(x+5)$ cm, the magnification of the image becomes 2. The focal length of the mirror is

(a) 15 cm (b) 20 cm (c) 25 cm (d) 30 cm

31. The ratio of magnetic field and magnetic moment at the centre of a current carrying circular loop is x. When both the current and radius is doubled the ratio will be

(a) $\frac{x}{8}$ (b) $\frac{x}{4}$ (c) $\frac{x}{2}$ (d) $2x$

32. In an adiabatic change, the pressure P and temperature T of a monoatomic gas are related by the relation $P\propto T^c$ where c equal to

(a) $\frac{5}{3}$ (b) $\frac{2}{5}$ (c) $\frac{3}{5}$ (d) $\frac{5}{2}$

33. A magnet is suspended in such a way that it oscillates in the horizontal plane. It makes 20 oscillations per minute at a place where dip angle is 30° and 15 oscillations per minute at a place where dip angle is 60°. The ratio of earth's magnetic fields at two places is

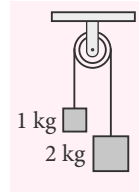
(a) $3\sqrt{3}:8$ (b) $16:9\sqrt{3}$

(c) $4:9$ (d) $2\sqrt{2}:3$

34. A radioactive isotope has a half life of 2 yr. How long will it take the activity to reduce to 3% of its original value?

(a) 4.8 yr (b) 7 yr (c) 10 yr (d) 9.6 yr

35. Two unequal masses are connected on two sides of a light string passing over a light and smooth pulley as shown in figure. The system is released from rest. The larger mass is stopped for a moment, 1.0 s after the system is set into motion. The time elapsed before the string is tight again is (Take $g = 10$ m s^{-2})



(a) $\frac{1}{4}$ s (b) $\frac{1}{2}$ s (c) $\frac{2}{3}$ s (d) $\frac{1}{3}$ s

36. The equation for the vibration of a string fixed at both ends vibrating in its third harmonic is given by

$y = 2\sin(0.6x)\cos(500\pi t)$

where x and y are in cm and t in s.

The length of the string is

(a) 24.6 cm (b) 12.5 cm

(c) 20.6 cm (d) 15.7 cm

37. The relation between U, P and V for an ideal gas in an adiabatic process is given by

$U = 2 + 3PV$

The gas is

(a) monoatomic

(b) diatomic

(c) polyatomic

(d) either a monoatomic or diatomic

38. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of the virtual image from the surface of the sphere is

(a) 2 cm (b) 4 cm (c) 6 cm (d) 12 cm

39. An electron of mass m_e, initially at rest, moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p, also, initially at rest, takes time t_2 to move through an equal distance in this uniform electric field. Neglecting the effect of gravity, the ratio $\frac{t_2}{t_1}$ is nearly equal to

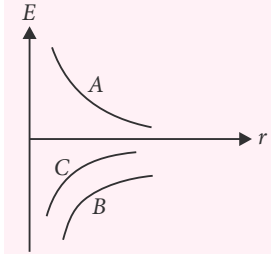
(a) 1 (b) $\sqrt{\frac{m_p}{m_e}}$

(c) $\sqrt{\frac{m_e}{m_p}}$ (d) 1836

40. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{L/g}$. Measured value of L is 10 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 50 s using a wrist watch of 1 s resolution. What is the accuracy in the determination of g?

(a) 2% (b) 3% (c) 4% (d) 5%

41. Figure shows the variation of energy E with the orbital radius r of a satellite in a circular motion. Mark the correct statement.



(a) A shows the kinetic energy, B shows the total energy and C the potential energy of the satellite.

(b) A and B are the kinetic energy and potential energy respectively and C the total energy of the satellite.

(c) A and B are the potential energy and kinetic energy respectively and C the total energy of the satellite.

(d) C and A are the kinetic and potential energies and B the total energy of the satellite.

42. Resultant of two vectors $\vec{A}$ and $\vec{B}$ is of magnitude P. If $\vec{B}$ is reversed, then resultant is of magnitude Q. What is the value of $P^2 + Q^2$?

(a) $2(A^2 + B^2)$ (b) $2(A^2 - B^2)$

(c) $A^2 - B^2$ (d) $A^2 + B^2$

43. A body executes SHM with an amplitude A. The displacement of the body when its kinetic energy is one-fourth of the total energy is

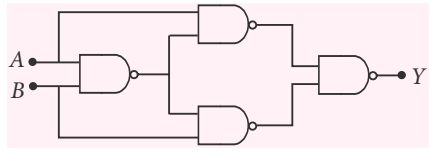
(a) $\frac{A}{2}$ (b) $\frac{A}{\sqrt{2}}$ (c) $\frac{\sqrt{3}}{2}A$ (d) $\frac{2}{\sqrt{3}}A$

44. In a series LCR circuit the voltage across the resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited, the voltage across the inductance will be

(a) 10 V (b) $10\sqrt{2}$ V

(c) $\frac{10}{\sqrt{2}}$ V (d) 20 V

45. The simplified Y output of the given logic circuit is



(a) $\bar{A}\cdot B + A\cdot\bar{B}$ (b) $A\cdot\bar{B} + A\cdot B$

(c) $\bar{A}\cdot\bar{B} + A\cdot B$ (d) $A\cdot\bar{B} + \bar{A}\cdot\bar{B}$

CHEMISTRY

46. If the average velocity of He is $\sqrt{8}$ times that of O_2 gas, then

(a) $T_{He} = T_{O_2}$ (b) $T_{He} > T_{O_2}$

(c) $T_{He} < T_{O_2}$ (d) none of these.

47. Total number of stereoisomers of the compound 2, 4-dichloroheptane is

(a) 2 (b) 3 (c) 4 (d) 6

48. In which case, the energy released is minimum?

(a) $Cl \rightarrow Cl^-$ (b) $P \rightarrow P^-$

(c) $N \rightarrow N^-$ (d) $C \rightarrow C^-$

49. How many grams of dibasic acid (mol. wt. 200) should be present in 100 mL of the aqueous solution to give strength of 0.1 N?

(a) 10 g (b) 2 g (c) 1 g (d) 20 g

50. The presence of five —OH groups in glucose is established by its reaction with

(a) $(CH_3CO)_2O/ZnCl_2$

(b) NH_2OH

(c) $H_2NNHC_6H_5$

(d) HNO_3

51. Me_2SiCl_2 on hydrolysis produces

(a) $Me_2Si(OH)_2$

(b) $Me_2Si{=}O$

(c) $(-O-Me_2Si-O-)_n$

(d) $Me_2SiCl(OH)$

52. Which of the following statements does not form a part of Bohr's model of hydrogen atom?

(a) Energies of the electrons in the orbits are quantized.

(b) The electron in the orbit nearest the nucleus has the lowest energy.

(c) Electrons revolve in different orbits around the nucleus.

(d) The position and velocity of the electrons in the orbit cannot be determined simultaneously.

53. Westron and westrosol are respectively
(a) $CHCl_2 - CHCl_2$ and $CHCl = CCl_2$
(b) $CHCl = CCl_2$ and $CHCl_2 - CHCl_2$
(c) both are the names of $CHCl_2 - CHCl_2$
(d) both are the names of $CHCl = CCl_2$.

54. Water gas is produced by
(a) passing steam through a red hot coke bed
(b) saturating hydrogen with moisture
(c) mixing oxygen and hydrogen in the ratio of 1 : 2
(d) heating a mixture of CO_2 and CH_4 in petroleum refineries.

55. The correct order in which O — O bond length increases in the following is
(a) $O_3 < H_2O_2 < O_2$ (b) $O_2 < O_3 < H_2O_2$
(c) $O_2 < H_2O_2 < O_3$ (d) $H_2O_2 < O_2 < O_3$

56. The most suitable method for the separation of a mixture of *ortho* and *para*-nitrophenols mixed in the ratio of 1 : 1 is
(a) vaporisation (b) crystallisation
(c) distillation (d) colour spectrum.

57. Which of the following is expected to be acidic?
(a) CrO (b) CrO_2 (c) Cr_2O_3 (d) CrO_3

58. In an experiment, 4 g of M_2O_x oxide was reduced to 2.8 g of the metal. If the atomic mass of the metal is 56 g mol^{-1}, the number of O-atoms in the oxide is
(a) 1 (b) 2 (c) 3 (d) 4

59. In the following reaction, the organic product is

$CH_3CH_2NH_2 + CS_2 + HgCl_2 \xrightarrow{\Delta} ?$

(a) ethyl isocyanide (b) ethyl cyanide
(c) diethyl thiourea (d) ethyl isothiocyanate.

60. Which of the following complexes is paramagnetic with two unpaired electrons?
(a) $K_3[Fe(CN)_6]$ (b) $K_2[NiCl_4]$
(c) $K_2[CoCl_4]$ (d) $Na_2[Ni(CN)_4]$

61. The closest packing sequence *ABCABC*..... represents
(a) primitive cubic packing
(b) body-centred cubic packing
(c) face-centred cubic packing
(d) hexagonal packing.

62. A variety of synthetic rubber which is fire resistant and can be used for making containers to store organic solvents, oils, etc., is
(a) vulcanised rubber (b) styrene-butadiene rubber
(c) duprene (d) teflon.

63. Aqueous solution of borax is
(a) acidic towards litmus
(b) basic towards litmus
(c) neutral towards litmus
(d) weakly acidic and no change on litmus.

64. What is the colour of the end product '*Y*' of the following set of reactions?

Phenol + Phthalic anhydride $\xrightarrow[\Delta]{\text{conc. } H_2SO_4} X \xrightarrow{NaOH} Y$

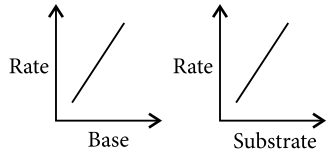
(a) Green (b) Blue (c) Pink (d) Yellow

65. Which of the following periodic properties is/are not regular in halogen family on moving down the group?
(I) Ionisation energy
(II) Electron gain enthalpy
(III) Size
(IV) Electronegativity
(a) I and II (b) I, III and IV
(c) II and IV (d) Only II

66. What is the concentration of Cl^- ions in saturated solution if K_{sp} of $HgCl_2$ at 298 K is 4×10^{-15} ?
(a) 1×10^{-5} M (b) 2×10^{-5} M
(c) 4×10^{-5} M (d) 4×10^{-15} M

67. For the reaction, $CO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow CO_{2(g)}$, ΔH and ΔS are –283 kJ and –97 J K^{-1}. It was intended to carry out this reaction at 1000 K, 1500 K, 3000 K and 3500 K. At which of these temperatures would this reaction be thermodynamically spontaneous?
(a) 1500 K and 3500 K
(b) 1000 K and 1500 K
(c) 1000 K, 1500 K and 3000 K
(d) 1500 K, 3000 K and 3500 K

68. Which of the following statements is not correct about S_N2 reaction?
(a) Rate of S_N2 reaction is directly proportional to the dielectric constant of the medium.
(b) Rate of S_N2 reaction is directly proportional to the nature of the leaving group.
(c) Rate of S_N2 reaction is inversely proportional to the steric hindrance present in substrate.
(d)



69. The decreasing tendency to occur as puckered ring of 8-atoms in 16th group is in the order
(a) Po > Te > Se > S (b) Te > Se > S > Po
(c) S > Se > Te > Po (d) S > Po > Te > Se

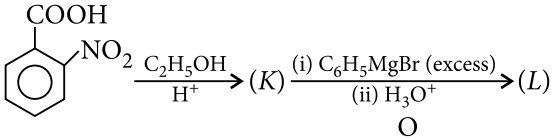
70. If the slope of graph between $\log\left(\frac{x}{m}\right)$ and $\log P$ is 1 with intercept 0.301, the extent of adsorption at a pressure of 0.2 atm, is
(a) 0.2 (b) 0.4 (c) 0.6 (d) 0.8

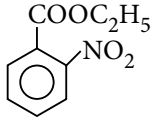
71. The method of zone refining of metals is based on the principle of
(a) greater mobility of the pure metal than that of the impurity
(b) higher melting point of the impurity than that of the pure metal
(c) greater noble character of the solid metal than that of the impurity
(d) greater solubility of the impurity in the molten state than in the solid.

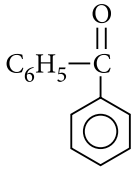
72. Which compound has planar structure?
(a) XeF_4 (b) $XeOF_2$
(c) XeO_2F_2 (d) XeO_4

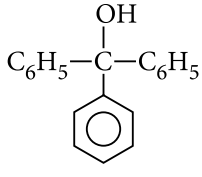
73. The oxidation numbers of S in $H_2S_2O_8$, $H_2S_2O_4$ and $H_2S_2O_6$ are respectively
(a) +3, +4, +5 (b) +5, +4, +3
(c) +6, +3, +5 (d) +3, +5, +4

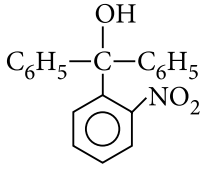
74. In the given reaction final compound (*L*) is



(a) 

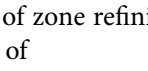
(b) 

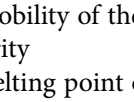
(c) 

(d) 

75. In Antarctica, ozone depletion is due to the formation of which one of the following compounds?
(a) Acrolein (b) Peroxyacetyl nitrate
(c) SO_2 and SO_3 (d) Chlorine nitrate

76. If K_1 and K_2 are the respective equilibrium constants for the two reactions :
$XeF_{6(g)} + H_2O_{(g)} \rightarrow XeOF_{4(g)} + 2HF_{(g)}$,
$XeO_{4(g)} + XeF_{6(g)} \rightarrow XeOF_{4(g)} + XeO_3F_{2(g)}$,
the equilibrium constant of the reaction,
$XeO_{4(g)} + 2HF_{(g)} \rightarrow XeO_3F_{2(g)} + H_2O_{(g)}$,
will be
(a) K_1/K_2 (b) $K_1 \cdot K_2$
(c) $K_1/(K_2)^2$ (d) K_2/K_1

77. C_8H_{14} on ozonolysis followed by hydrolysis in the presence of Zn, produces one mole of each of HCHO, CH_3COCH_3 and $OHCCH_2COCH_3$. The compound is
(a) 

(b) $CH_2{=}CH{-}CH_2{-}C(CH_3){=}C(CH_3)_2$
(c) 

(d) $CH_2{=}C(CH_3){-}CH_2{-}C(CH_3){=}C(CH_3)_2$

78. Which one of the following substances is used in the laboratory for fast drying of neutral gases?
(a) Sulphuric acid
(b) Activated charcoal
(c) Anhydrous calcium chloride
(d) Sodium phosphate

79. What is the ratio of weights liberated at cathodes when the same current is passed through two solutions of ferric and ferrous salts arranged in series for a given time interval?
(a) 3 : 2 (b) 2 : 3
(c) 1 : 3 (d) 3 : 1

80. Isoelectric point of alanine is 6.1. Above pH 7, the alanine molecule will occur as
(a) $NH_2{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}{-}COOH$ (b) $H_3\overset{+}{N}{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}{-}COO^-$
(c) $H_2N{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}{-}COO^-$ (d) $H_3\overset{+}{N}{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}{-}COOH$

81. Among $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ species, the hybridisation states at the Ni-atom are respectively
(a) sp^3, dsp^2, dsp^2 (b) sp^3, dsp^2, sp^3
(c) sp^3, sp^3, dsp^2 (d) dsp^2, sp^2, sp^3

82. Which of the following mixtures of gases does not obey Dalton's law of partial pressure?
(a) NH_3 and HCl (b) CO_2 and He
(c) O_2 and CO_2 (d) N_2 and O_2

83. In which of the following compounds, the asterisk C-atom is the most positively charged?
(a) $\overset{*}{C}H_3{-}CH_2{-}Cl$
(b) $\overset{*}{C}H_3{-}CH_2{-}Br$
(c) $\overset{*}{C}H_3{-}CH_2{-}\overset{+}{M}gCl^-$
(d) $\overset{*}{C}H_3{-}CH_2{-}CH_3$

84. Which of the following is not matched correctly?
(a) Magnesia cement : $MgCl_2 \cdot 5MgO \cdot xH_2O$
(b) Plaster of Paris : $CaSO_4 \cdot \frac{1}{2}H_2O$
(c) Black ash : $Na_2CO_3 \cdot CaS$
(d) Washing soda : $NaHCO_3$

85. Among LiCl, $BeCl_2$, BCl_3 and CCl_4, the covalent bond character follows the order
(a) $BeCl_2 > BCl_3 > CCl_4 > LiCl$
(b) $BeCl_2 < BCl_3 < CCl_4 < LiCl$
(c) $LiCl < BeCl_2 < BCl_3 < CCl_4$
(d) $LiCl > BeCl_2 > BCl_3 > CCl_4$

86. Which one of the following esters cannot undergo Claisen self-condensation?
(a) $C_6H_5CH_2COOC_2H_5$
(b) $C_6H_5COOC_2H_5$
(c) $CH_3CH_2CH_2CH_2COOC_2H_5$
(d) $C_6H_{11}CH_2COOC_2H_5$

87. If the size of lanthanide ions are in order $P^{3+}>Q^{3+}>R^{3+}>S^{3+}$ then *P*, *Q*, *R* and *S* are respectively
(a) Ce, Pm, Eu, Lu (b) Lu, Eu, Pm, Ce
(c) Pm, Ce, Lu, Eu (d) Lu, Ce, Pm, Eu

88. All form ideal solution except
(a) C_6H_6 and $C_6H_5CH_3$
(b) C_2H_6 and C_2H_5I
(c) C_6H_5Cl and C_6H_5Br
(d) C_2H_5I and C_2H_5OH

89. Nylon threads are made up of
(a) polyethylene polymer
(b) polyvinyl polymer
(c) polyester polymer
(d) polyamide polymer.

90. Choose the incorrect set.
(I) Oxidising nature : $(I_2 > Br_2 > Cl_2 > F_2)$
(II) IE_1 : (Na < Li < B < Be)
(III) EA_1 : (N < P < O < S)
(IV) Size of hydrated ion : $(Na^+ < Mg^{2+} < Al^{3+})$
(a) Only I (b) I, II
(c) I, II, III (d) All of these.

BIOLOGY

91. The phylogenetic system of classification was put forth by
(a) Carolus Linnaeus
(b) George Bentham and Joseph Dalton Hooker
(c) Aristotle
(d) Adolf Engler and Karl Prantl.

92. Which one of the taxonomic aids can give comprehensive account of complete compiled information of any one genus or family at a particular time?
(a) Taxonomic key (b) Flora
(c) Herbarium (d) Monograph

93. In five kingdom system, the main basis of classification is
(a) structure of nucleus
(b) mode of nutrition
(c) structure of mitochondria
(d) asexual reproduction.

94. The cell wall of a bacterium is made up of
(a) cellulose (b) hemicellulose
(c) lignin (d) peptidoglycan.

95. Match Column I with Column II and select the correct option.

Column I (Shapes of chloroplast)	Column II (Algae)
A. Cup shaped	1. *Ulothrix*
B. Girdle shaped	2. *Oedogonium*
C. Stellate	3. *Chlamydomonas*
D. Reticulate	4. *Zygnema*

(a) A – 2, B – 4, C – 3, D – 1
(b) A – 3, B – 1, C – 4, D – 2
(c) A – 3, B – 4, C – 2, D – 1
(d) A – 4, B – 3, C – 1, D – 2.

96. Which pteridophyte is called as horse-tail?
(a) *Equisetum* (b) *Lycopodium*
(c) *Marsilea* (d) *Selaginella*.

97. Which of the following structure will best help in identifying Arthopoda from Annelida?
(a) Segmented body (b) Nephridia
(c) Eyes (d) None.

98. The long neck of a camel is due to
(a) muscle in between two vertebrae
(b) bony plate between two vertebrae
(c) increase in length of cervical vertebrae
(d) none of the above.

99. Tendons and ligaments are specialized types of
(a) nervous tissue (b) muscular tissue
(c) epithelial tissue (d) fibrous connective tissue.

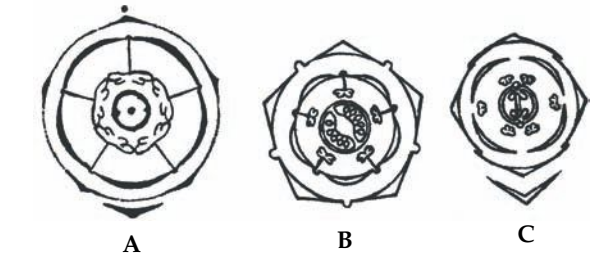
100. In cockroach, the ootheca is formed by the secretion of
(a) phallic gland (b) collaterial gland
(c) mushroom gland (d) conglobate gland.

101. The receptacle is flattened at the top and bears numerous sessile flowers in centripetal order in
(a) cyathium (b) catkin
(c) umbel (d) verticillaster.

102. In the leaf vascular bundles are found in the
(a) veins
(b) palisade parenchyma
(c) spongy parenchyma
(d) all of these.

103. Which one of the following is an example of sub-aerial modification of stem ?
(a) *Agave* (b) *Oxalis*
(c) *Asparagus* (d) *Tridax*

104. Three floral diagrams are given here. Their respective families are assigned in the answer key. Find out the families to which these diagrams belong to.



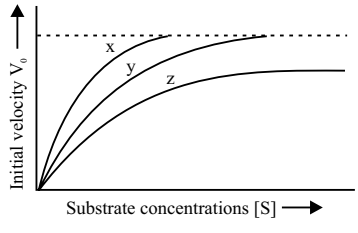
(a) A - Liliaceae, B - Asteraceae, C - Solanaceae
(b) A - Asteraceae, B - Solanaceae, C - Brassicaceae
(c) A - Asteraceae, B - Fabaceae, C - Poaceae
(d) A - Poaceae, B - Solanaceae, C - Asteraceae

105. Animal cell differs from plant cells in not having the
(a) cell wall (b) plastids
(c) glyoxysomes (d) all of these.

106. Three of the following statements regarding cell organelles are correct while one is wrong. Which one is wrong?
(a) Lysosomes are single membraned vesicles budded off from Golgi apparatus and contain digestive enzymes.
(b) Endoplasmic reticulum consists of a network of membranous tubules and helps in transport, synthesis and secretion.
(c) Leucoplasts are bound by two membranes, lack pigment but contain their own DNA and protein synthesizing machinery.
(d) Sphaerosomes are single membrane bound and are associated with synthesis and storage of lipids.

107. Select the incorrect statement.
(a) Amino acids are substituent methanes.
(b) Glycerol is a trihydroxy propane.
(c) Lysine is a neutral amino acid.
(d) Lecithin is a phospholipid.

108. The given figure shows three velocity-substrate concentration curves for an enzyme reaction. What do the curves x, y, and z depict respectively ?



(a) x-Normal enzyme reaction, y-Competitive inhibition, z-Non-competitive inhibition
(b) x-Enzyme with an allosteric modulator added, y-Normal enzyme activity, z-Competitive inhibition
(c) x-Enzyme with an allosteric stimulator, y-Competitive inhibition added, z-Normal enzyme reaction
(d) x-Normal enzyme reaction, y-Non-competitive inhibitor added, z-Allosteric inhibitor added.

109. Pairing or synapsis between homologous chromosomes occur during
(a) leptotene (b) pachytene
(c) zygotene (d) diplotene.

110. During the cell cycle, 2 molecules of DNA are present in a chromosome in the
(a) G_1-phase (b) beginning of S-phase
(c) G_2-phase (d) end of M-phase.

111. Which of the following is not a purpose of transpiration?
(a) Helps in absorption and transport in plants.
(b) Prevents loss of water.
(c) Maintains shape and structure of plants by keeping the cell turgid.
(d) Supplies water for photosynthesis.

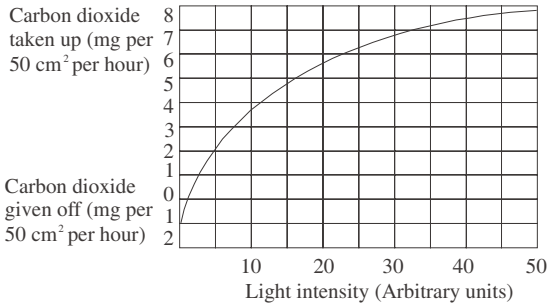
112. Which of the following relations is correct ?
(a) $\psi_w = \psi_s - \psi_p$ (b) $\psi_w = \psi_m + \psi_s + \psi_p$
(c) $\psi_w = \psi_s + \psi_p$ (d) $\psi_w = \psi_m - \psi_s + \psi_p$.

113. Hydroponics is
(a) cultivation of plants in pure water
(b) growth of plants towards water
(c) growth of plants away from water
(d) soil-less cultivation of plants.

114. The macronutrient which is an essential component of all organic compounds, yet not obtained by plants from soil, is
(a) nitrogen (b) carbon
(c) phosphorous (d) magnesium.

115. Final electron acceptor in ETS is
(a) H_2O (b) O_2 (c) cyt a_3 (d) cyt a.

116. The graph shows the relation between light intensity and the giving off and taking up of carbon dioxide by the leaves of a plant. Why is most carbon dioxide given off when the light intensity is zero units?



(a) Because it is just the start of the experiment
(b) Only respiration is taking place at this intensity of light
(c) Only photosynthesis is taking place at this intensity of light
(d) The rate of photosynthesis is equivalent to the rate of respiration.

117. The creation of proton gradient across the thylakoid membrane is a result of
(a) decrease in proton number in stroma
(b) accumulation of protons in the lumen
(c) decrease in the pH in the lumen
(d) all of the above.

118. Match the number of carbon atoms given in List - I with that of the compounds given in List - II and select the correct option.

	List - I		List - II
A.	4C Compound	1.	Acetyl CoA
B.	2C Compound	2.	Pyruvate
C.	5C Compound	3.	Citric acid
D.	3C Compound	4.	α-keto glutaric acid
		5.	Malic acid

(a) A – 2, B – 5, C – 3, D – 1
(b) A – 5, B – 1, C – 4, D – 2
(c) A – 3, B – 1, C – 4, D – 2
(d) A – 5, B – 3, C – 1, D – 2.

119. Chemiosmotic theory of ATP synthesis in the mitochondrion is based on
(a) Ca^{++} gradient (b) K^+ gradient
(c) H^+ gradient (d) Na^+ gradient.

120. In Kreb's cycle, OAA accepts acetyl CoA to form
(a) citric acid (b) oxalosuccinate
(c) fumarate (d) succinyl CoA.

121. Match the items in Column - I with Column - II and choose the correct option.

	Column I		Column II
A.	Human urine	1.	Cytokinin
B.	*Gibberella fujikuroi*	2.	Auxin
C.	Herring sperm DNA	3.	Ethylene
D.	Ripening fruits	4.	Abscisic acid
E.	Aged leaves of plants	5.	Gibberellins

(a) A – 2, B – 5, C – 1, D – 3, E – 4
(b) A – 2, B – 3, C – 4, D – 5, E – 1
(c) A – 1, B – 5, C – 2, D – 4, E – 3
(d) A – 5, B – 4, C – 3, D – 2, E – 1.

122. Under the anaeorbic conditions, denitrifying bacteria such as *Pseudomonas* could convert
(a) nitrates to ammonia
(b) nitrites to nitrates
(c) nitrates to molecular nitrogen
(d) nitrates to nitrites.

123. Which one of the following pairs of kind of cells and their secretion is correctly matched ?
(a) Oxyntic cells - A secretion with pH between 2.0 and 3.0
(b) Alpha cells of islets of Langerhans - Secretion that decreases blood sugar level
(c) Kupffer cells - A digestive enzyme that hydrolyses nucleic acids
(d) Sebaceous glands - A secretion that evaporates for cooling.

124. Brunner's gland are found in
(a) liver
(b) pancreas
(c) mucosa of intestine
(d) oesophageal wall.

125. Succus entericus is secreted by
(a) crypts of Lieberkuhn
(b) Brunner's gland
(c) both (a) & (b)
(d) none of these.

126. Which one of the following statements is incorrect?
(a) The principle of countercurrent flow facilitates efficient respiration in gills of fishes
(b) The residual air in lungs slightly decreases the efficiency of respiration in mammals
(c) The presence of non-respiratory air sacs, increases the efficiency of respiration in birds
(d) In insects, circulating body fluids serve to distribute oxygen to tissues.

127. A person breathing normally at rest, takes in and expels approximately half a litre of air during each respiratory cycle. This is called
(a) inspiratory reserve volume
(b) tidal volume
(c) expiratory reserve volume
(d) vital capacity.

128. Which one of the following is a matching pair?
(a) Lubb - sharp closure of AV valves at the beginning of ventricular systole
(b) Dup - sudden opening of semilunar valves at the beginning of ventricular diastole
(c) Pulsation of the radial artery - valves in the blood vessels
(d) Initiation of the heart beat - Purkinje fibres

129. Which of the following types of leucocytes are characterized by the presence of S-shaped nucleus?
(a) Eosinophil (b) Basophil
(c) Neutrophil (d) Monocyte

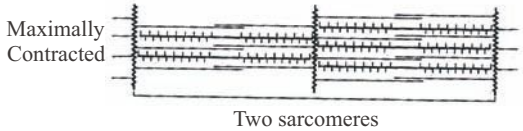
130. Which one of the following statements in regard to the excretion by the human kidneys is correct?
(a) Descending limb of loop of Henle is impermeable to water
(b) Distal convoluted tubule is incapable of reabsorbing HCO_3^-
(c) Nearly 99 per cent of the glomerular filtrate is reabsorbed by the renal tubules
(d) Ascending limb of loop of Henle is impermeable to electrolytes.

131. Which of following are metabolic wastes of protein metabolism?
(a) Urea, oxygen and N_2
(b) Urea, NH_3 and CO_2
(c) Ammonia, urea and creatinine
(d) Nitrogen, urea and CO_2

132. In micturition
(a) urethra relaxes (b) ureter relaxes
(c) ureter contracts (d) urethra contracts.

133. Inter-articulated disc is found in
(a) pubic symphysis (b) wall of heart
(c) wall of liver (d) vertebrae.

134. Which of the following is correct about the given figure?



Two sarcomeres

(a) The length of the thick and thin myofilaments has changed.
(b) Length of both anisotropic and isotropic band has changed.
(c) The myosin cross-bridges move on the surface of actin and the thin and thick myofilaments slide past each other.
(d) Length of the sarcomere remains same.

135. The correct sequence of meninges from inner to outer side is
(a) duramater → arachnoid membrane → piamater
(b) duramater → piamater → arachnoid membrane
(c) piamater → arachnoid membrane → duramater
(d) arachnoid membrane → duramater → piamater.

136. The arrangement of ear ossicles in mammalian ear is
(a) columella, malleus, incus
(b) incus, malleus stapes
(c) stapes, malleus, incus
(d) malleus, incus, stapes.

137. Addison's disease results from
(a) hyposecretion of adrenal cortex
(b) hypertrophy of gonads
(c) hyperactivity of cells of Leydig
(d) none of the above.

138. Which of the following is due to abnormal secretion of thyroxine?
(a) Goitre (b) Acromegaly
(c) Diabetes (d) Addison's disease

139. In spermatogenesis, the acrosome of sperm is formed by
(a) Golgi complex (b) mitochondria
(c) lysosome (d) nucleus.

140. The mammalian corpus luteum produces
(a) prolactin
(b) luteotropic hormone
(c) progesterone
(d) luteinizing hormone.

141. Vitellogenesis occurs during the formation of
(a) ootid in the Fallopian tube
(b) secondary oocyte in the Fallopian tube
(c) primary oocyte in the Graafian follicle
(d) oogonial cell in the Graafian follicle.

142. Tubectomy prevents pregnancy by
(a) preventing fertilization
(b) preventing ovulation
(c) altering FSH levels in ovary
(d) altering LH levels in ovary.

143. Which is non-invasive technique of genetic counselling?
(a) Amniocentesis
(b) Chorionic biopsy
(c) Foetal blood sampling
(d) Ultrasonography

144. Diaphragms are contraceptive devices used by the females. Choose the correct option from the statements given below.
(i) They are introduced into the uterus.
(ii) They are placed to cover the cervical region
(iii) They act as physical barriers for sperm entry
(iv) They act as spermicidal agents.
(a) (i) and (ii) (b) (i) and (iii)
(c) (ii) and (iii) (d) (iii) and (iv)

145. Starting from the innermost part, the correct sequence of parts in an ovule is
(a) egg, nucellus, embryo sac, integument
(b) egg, embryo sac, nucellus, integument
(c) embryo sac, nucellus, integument, egg
(d) egg, integument, embryo sac, nucellus.

146. The phenomenon observed in some plants wherein parts of the sexual apparatus is used for forming embryos without fertilization is called
(a) parthenocarpy
(b) apomixis
(c) vegetative propagation
(d) sexual reproduction.

147. Identify the parts labelled A, B, C and D in the given diagram from the list (i-vii) and select the correct option.

Components:
(i) Scutellum
(ii) Coleoptile
(iii) Shoot apex
(iv) Epiblast
(v) Radicle
(vi) Root cap
(vii) Coleorrhiza.

	A	B	C	D
(a)	(i)	(vi)	(vii)	(ii)
(b)	(ii)	(vii)	(v)	(i)
(c)	(iv)	(iii)	(vi)	(vii)
(d)	(iii)	(vii)	(vi)	(ii).

148. Match list I with list II and select the correct option.

	List I		List II
A.	Gemmules	1.	*Agave*
B.	Leaf-buds	2.	*Penicillium*
C.	Bulbil	3.	Water hyacinth
D.	Offset	4.	Sponges
E.	Conidia	5.	*Bryophyllum*

(a) A – 4, B – 5, C – 1, D – 3, E – 2
(b) A – 4, B – 3, C – 2, D – 1, E – 5
(c) A – 3, B – 5, C – 4, D – 2, E – 1
(d) A – 4, B – 1, C – 5, D – 3, E – 2.

149. A few statements describing certain features of reproduction are given below:
i. Gametic fusion takes place
ii. Transfer of genetic material takes place
iii. Reduction division takes place
iv. Progeny have some resemblance with parents.
Select the options that are true for both asexual and sexual reproduction from the options given below.
(a) (i) and (ii) (b) (ii) and (iii)
(c) (ii) and (iv) (d) (i) and (iii).

150. There is no natural death in single celled organisms like *Amoeba* and bacteria because
(a) they cannot reproduce sexually
(b) they reproduce by binary fission
(c) parental body is distributed among the offspring
(d) they are microscopic.

151. In a dihybrid cross, if you get 9 : 3 : 3 : 1 ratio, it denotes that
(a) the alleles of two genes are interacting with each other
(b) it is a multigenic inheritance
(c) it is case of multiple allelism
(d) the alleles of two genes are segregating independently.

152. If a normal woman marries a colourblind man
(a) all their sons will be colourblind but the daughters will be normal
(b) all daughters will be colourblind and sons will be normal
(c) all the children will be normal
(d) all sons and 50% of daughters are normal but 50% daughters will be colourblind.

153. Phenylketonuria is a genetic disorder of
(a) trisomic condition
(b) monosomic condition
(c) autosomal dominant gene
(d) autosomal recessive gene.

154. Which of the following genotypes does not produce any sugar polymer on the surface of the RBC?
(a) I^AI^A (b) I^Bi
(c) I^AI^B (d) *ii*

155. The main aim of the human genome project is
(a) to introduce new genes into humans
(b) to identify and sequence all the genes present in human DNA
(c) to develop better techniques for comparing two different human DNA samples
(d) to remove disease causing genes from human DNA.

156. Select the correct statement regarding protein synthesis.
(a) When the small subunit of the ribosome encounters an *m*RNA the process of translation begins.
(b) Peptidase catalyses the formation of peptide bond.
(c) UTRs are present between the start codon and stop codon.
(d) At the end of translation the release factor binds to the initiation codon.

157. The most accepted line of descent in human evolution is
(a) *Australopithecus* → *Ramapithecus* → *Homo sapiens* → *Homo habilis*
(b) *Homo erectus* → *Homo habilis* → *Homo sapiens*
(c) *Ramapithecus* → *Homo habilis* → *Homo erectus* → *Homo sapiens*
(d) *Australopithecus* → *Ramapithecus* → *Homo erectus* → *Homo habilis* → *Homo sapiens*.

158. In case of evolution which of the following statement is not correct ?
(a) Fossilized animals provide important information to trace evolution.
(b) Forelimbs of man and cheetah are homologous.
(c) In higher animals early development stages are similar.
(d) Variation among individuals are not important in natural selection.

159. 'Smack' is a drug obtained from the
(a) latex of *Papaver somniferum*
(b) leaves of *Cannabis sativa*
(c) flowers of *Dhatura*
(d) fruits of *Erythroxyl coca*.

160. Identify the wrongly matched pair.
(a) Typhoid – Widal test
(b) Plague – Viral disease
(c) Malignant malaria – *Plasmodium falciparum*
(d) Common cold – Rhinovirus

161. Cancer is generally caused due to activation of _____ to _____and/or inactivation of _____.
(a) oncogene, tumor suppressor gene, protooncogene
(b) tumor suppressor gene, oncogene, protooncogene
(c) protooncogene, oncogene, tumor suppressor gene
(d) oncogene, protooncogene, tumor suppressor gene.

162. Given below are a few statements regarding somatic hybridization. Choose the correct statements.
(i) Protoplasts of different cells of the same plant are fused.
(ii) Protoplasts from cells of different species can be fused.
(iii) Treatment of cells with cellulase and pectinase is mandatory.
(iv) The hybrid protoplast contains characters of only one parental protoplast.
(a) (ii) and (iii) (b) (i) and (ii)
(c) (iii) and (iv) (d) (i) and (iii).

163. Artificial breeding of cattle is brought about by
(a) artificial insemination
(b) superovulation
(c) embryo transplantation
(d) all of the above.

164. Match the following and choose the correct combination from the options given.

	Column I		Column II
A.	Electrocardiography	1.	To view within the body without cutting through overlying tissues
B.	Endoscopy	2.	A graphic recording of electric activity of heart
C.	MRI	3.	A graphic recording of electric activity of brain
D.	Electro-encephalography	4.	A technique that gives anatomical images in multiple planes.

(a) A-1, B-3, C-4, D-2 (b) A-1, B-2, C-4, D-3
(c) A-2, B-3, C-4, D-1 (d) A-2, B-1, C-4, D-3

165. What strategy would you suggest if a person wants to evolve a pureline in an animal?
(a) Crossbreeding (b) Inbreeding
(c) Outbreeding (d) Artificial insemination.

166. Big holes in Swiss cheese are made by a
(a) a machine
(b) a bacterium that produces methane gas.
(c) a bacterium producing a large amount of carbon dioxide.
(d) a fungus that releases a lot of gases during its metabolic activities.

167. Which of the following organism is used in the production of human insulin by genetic engineering?
(a) *Escherichia coli*
(b) *Agrobacterium tumefaciens*
(c) *Bacillus thuringiensis*
(d) *Saccharomyces cerevisiae*.

168. Which one of the following is a correct statement?
(a) "Bt" in "Bt-cotton" indicates that it is a genetically modified organism produced through biotechnology.
(b) Somatic hybridization involves fusion of two complete plant cells carrying desired genes.
(c) The anticoagulant hirudin is being produced from transgenic *Brassica napus* seeds.
(d) "Flavr savr" variety of tomato has enhanced the production of ethylene which improves its taste.

169. If a recombinant DNA bearing gene for ampicillin resistance is transferred into *E. coli* cells and the host cells are spread on agar plates containing ampicillin, then
(a) both transformed and untransformed recipient cells will die
(b) both transformed and untransformed recipient cells will grow
(c) transformed recipient cells will grow and untransformed recipient cells will die
(d) transformed recipient cells will die and untransformed recipient cells will grow.

170. The most important feature in a plasmid to be used as a vector is
(a) origin of replication (ori)
(b) presence of a selectable marker
(c) presence of sites for restriction endonuclease
(d) all of these.

171. Which of the following would necessarily decrease the density of a population in a given habitat?
(a) Natality and mortality
(b) Immigration and emigration
(c) Mortality and emigration
(d) Natality and immigration.

172. The sequence of communities of primary succession in water is
(a) phytoplankton, sedges, free-floating hydrophytes, rooted hydrophytes, grasses and trees.
(b) phytoplankton, free-floating hydrophytes, rooted hydrophytes, sedges, grasses and trees.
(c) free-floating hydrophytes, sedges, phytoplankton, rooted hydrophytes, grasses and trees.
(d) phytoplankton, rooted submerged hydrophytes, floating hydrophytes, reed swamp, sedges, marsh meadow and trees.

173. Which of the following shows Verhulst Pearl logistic growth?
(a) $dN/dt = rN\left(\frac{K-N}{K}\right)$
(b) $N_t = N_o e^{rt}$
(c) $dN/dt = rN$
(d) $rN\left(\frac{K-N}{K}\right)$

174. Which of the following statements regarding food chain is false?
(a) In an aquatic ecosystem, grazing food chain is the major conduit for energy flow.
(b) In terrestrial ecosystems, a large fraction of energy flows through detritus food chain.
(c) The detritus food chain begins with dead organic matter.
(d) Primary consumers belong to the first trophic level.

175. In a food web, each successive trophic level has
(a) increased total energy
(b) more total energy
(c) less total energy
(d) non estimated energy content.

176. Hot spots are priority areas for *in situ* conservation. The key criteria for determining a hot spot is/are
(a) location in developed/undeveloped country
(b) vicinity to the sea
(c) number of endemic species and degrees of threat
(d) all of the above.

177. Which of the following statements is correct?
(a) *Parthenium* is an endemic species of our country.
(b) African catfish is not a threat to indigenous catfishes.
(c) Steller's sea cow is an extinct animal.
(d) *Lantana* is popularly known as carrot grass.

178. Algal blooms impart a distinct colour to water due to
(a) their pigments
(b) excretion of coloured substances
(c) formation of coloured chemicals in water facilitated by physiological degradation of algae.
(d) absorption of light by algal cell wall.

179. Calcium metabolism in birds gets disturbed due to the effect of
(a) mercury (b) cadmium
(c) DDT (d) lead.

180. The removal of lead and its products from petrol used in automobiles is necessary because lead
(a) causes loss of appetite
(b) causes anaemia
(c) hampers haemoglobin formation
(d) all of the above.

SOLUTIONS

1. (d): Here, $d = 0.05$ cm, $D = 100$ cm

$x = 0.36$ cm, $n = 4$

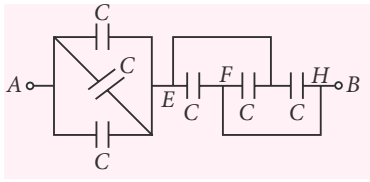
For bright fringes, $x = \dfrac{n\lambda D}{d}$ or $\lambda = \dfrac{xd}{nD}$

Substituting the values, we get

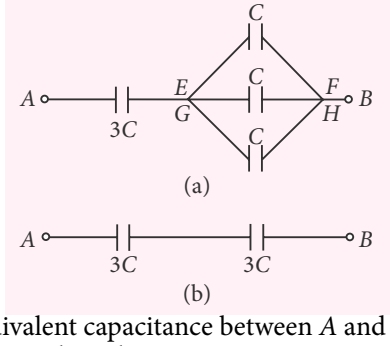
$$\lambda = \frac{(0.36\ \text{cm}) \times (0.05\ \text{cm})}{4 \times (100\ \text{cm})}$$

$$= 4.5 \times 10^{-5}\ \text{cm} = 4.5 \times 10^{-7}\ \text{m} = 4500\ \text{Å}$$

2. (a):



The equivalent circuit diagrams are as shown in the figure (a) and (b).



The equivalent capacitance between A and B is

$$\frac{1}{C_{eq}} = \frac{1}{3C} + \frac{1}{3C}$$

$$\frac{1}{C_{eq}} = \frac{2}{3C} \text{ or } C_{eq} = \frac{3}{2}C = 1.5C$$

3. (a): According to Einstein's photoelectric equation

$$h\upsilon = (\text{K.E.})_{max} + \phi_0$$

where ϕ_0 is the work function, υ is the incident frequency and h is the Planck's constant

Also, $(\text{K.E.})_{max} = eV$

where e is the elementary charge, V is the stopping potential

$$eV = h\upsilon - \phi_0$$

$$V = \frac{h}{e}\upsilon - \frac{\phi_0}{e}$$

Hence, the graph between V and υ is a straight line and slope of this graph is given by

$$\text{Slope} = \frac{h}{e} \quad \ldots(i)$$

From the graph in the question

$$\text{Slope} = \frac{ab}{bc} \quad \ldots(ii)$$

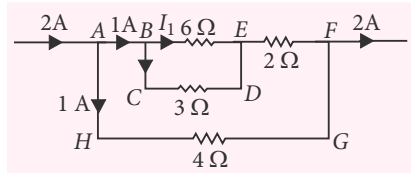
From (i) and (ii), we get

$$h = e\frac{ab}{bc}$$

4. (b): Jump to second orbit leads to Balmer series. When an electron jumps from 4th orbit to 2nd orbit, give rise to second line of Balmer series.

5. (b)

6. (a):



The resistance of arm $ABEF$ is $R = \dfrac{6 \times 3}{6 + 3} + 2 = 4\ \Omega$

As resistance of arms $ABEF$ and $AHGF$ is same, hence current in arm AB, $I = 1$ A

At junction B, $1 = I_1 + I_2$ …(i)

Potential difference across B and $E = 6I_1 = 3I_2$

or $I_2 = 2I_1$ …(ii)

Solving (i) and (ii), we get, $I_1 = \dfrac{1}{3}$ A, $I_2 = \dfrac{2}{3}$ A

Potential difference across $3\ \Omega = \dfrac{2}{3}\ \text{A} \times 3\ \Omega = 2$ V

7. (b): $\sin C = \dfrac{3}{5}$. Hence, $\mu = \dfrac{1}{\sin C} = \dfrac{5}{3}$

If i_p is the polarising angle, then

According to Brewster's law

$$\tan i_p = \mu \text{ or } i_p = \tan^{-1}(\mu) = \tan^{-1}\left(\frac{5}{3}\right)$$

8. (c): Young's modulus $Y = \dfrac{(F/A)}{\Delta l / l}$

or $\Delta l = \dfrac{(F/A)l}{Y}$ …(i)

Also, $\Delta l = \alpha l \Delta T$ …(ii)

As per question

$$\frac{(F/A)l}{Y} = \alpha l \Delta T \text{ or } \Delta T = \frac{F}{YA\alpha}$$

$$\Delta T = \frac{33000\ \text{N}}{(3 \times 10^{11}\ \text{N m}^{-2}) \times (10^{-3}\ \text{m}^2) \times (1.1 \times 10^{-5}\ ^\circ\text{C}^{-1})}$$

$$= 10\ ^\circ\text{C}$$

9. (d): In vacuum, all electromagnetic waves travel with the same speed $c (c = 3 \times 10^8\ \text{m s}^{-1})$.

10. (a): Given : $x = 24t - 2.0t^3$ m

$$\text{Velocity}, v = \frac{dx}{dt} = \frac{d}{dt}(24t - 2.0t^3)\ \text{m s}^{-1}$$

$$= 24 - 6t^2\ \text{m s}^{-1}$$

$$\text{Acceleration}, a = \frac{d^2x}{dt^2} = \frac{d}{dt}(24 - 6t^2)\ \text{m s}^{-2}$$

$$= -12t\ \text{m s}^{-2}$$

For $v = 0$, we get

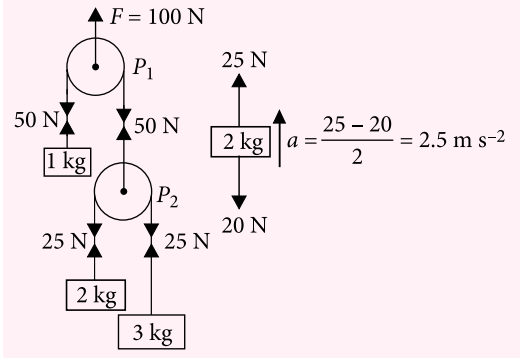
$24 - 6t^2 = 0$ or $t = 2$ s

Hence, at $t = 2$ s, the acceleration will be

$a = -12(2)$ m s^{-2} $= -24$ m s^{-2}

Its magnitude is 24 m s^{-2}.

11. (a) : From the equilibrium of pulley P_1 which is massless we can see that tension in upper string is 50 N. Similarly, from equilibrium of P_2 we can see that tension in lower string will be 25 N.



12. (a) : Here, in this case lens used by person should form the image of distant object at a distance of 40 cm in front of it.

$\therefore \quad u = -\infty, \; v = -40$ cm

and $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$ or $\dfrac{1}{f} = \dfrac{1}{-40} - \dfrac{1}{-\infty}$

or $\dfrac{1}{f} = \dfrac{1}{-40}$ or $f = -40$ cm

$\text{Power} = \dfrac{100}{f} = \dfrac{100}{-40} = -2.5$ D

Negative sign shows that lens used is concave lens.

13. (d): Rate of development of energy by the reactor $= 3000$ kW $= 3 \times 10^6$ J s^{-1}

Energy released per fission = 200 MeV

$= 200 \times 1.6 \times 10^{-13}$ J $= 32 \times 10^{-12}$ J

Number of atoms undergoing fission per second

$$= \frac{3 \times 10^6}{32 \times 10^{-12}} = 9.4 \times 10^{16}$$

14. (b): Total energy, $E = \dfrac{1}{2} m\omega^2 A^2$

$E = \dfrac{1}{2} m (2\pi\upsilon)^2 A^2 \qquad (\because \omega = 2\pi\upsilon)$

$\therefore \quad A = \dfrac{1}{2\pi\upsilon}\sqrt{\dfrac{2E}{m}}$

Putting $E = K + U$, we get

$$A = \frac{1}{2\pi(25/\pi)}\sqrt{\frac{2 \times (0.5 + 0.4)}{0.2}} = 0.06 \text{ m}$$

15. (b) **16. (b)**

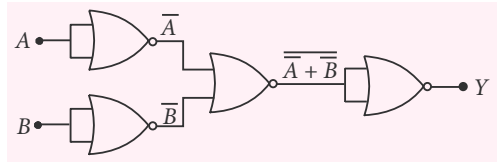
17. (c) : According to Wien's law $\lambda_m T =$ constant

or $(\lambda_m)_1 T_1 = (\lambda_m)_2 T_2$

or $11 \times 10^{-5} \times T_1 = (5.5 \times 10^{-5}) T_2$

$\therefore \quad T_1 = \dfrac{1}{2} T_2 \qquad \therefore \quad n = \dfrac{1}{2}$

18. (d):



$Y = \overline{\overline{A} + \overline{B}} = \overline{A} + \overline{B} = \overline{A \cdot B}$

It is a Boolean expression for NAND gate.

19. (a) : de Broglie wavelength of a moving particle, having mass m_p and velocity v_p is given by

$$\lambda_p = \frac{h}{p} = \frac{h}{m_p v_p} \text{ or } m_p = \frac{h}{\lambda_p v_p}$$

For an electron

$$\lambda_e = \frac{h}{m_e v_e} \text{ or } m_e = \frac{h}{\lambda_e v_e}$$

$$\text{Given}: \frac{v_p}{v_e} = 3, \; \frac{\lambda_p}{\lambda_e} = 1.813 \times 10^{-4}$$

$$\text{Mass of the particle, } m_p = m_e \left(\frac{v_e}{v_p}\right)\left(\frac{\lambda_e}{\lambda_p}\right)$$

Substituting the values, we get

$$m_p = (9.1 \times 10^{-31} \text{ kg}) \times \left(\frac{1}{3}\right) \times \left(\frac{1}{1.813 \times 10^{-4}}\right)$$

$m_p = 1.67 \times 10^{-27}$ kg

20. (c) : The coin placed on the rotating table slips when $mr\omega^2$ is greater than or equal to the static force of friction μmg. Mathematically,

$$mr\omega^2 \geq \mu mg \text{ or } r \geq \frac{\mu g}{\omega^2}$$

The coin just slips when $r = \dfrac{\mu g}{\omega^2}$

For radii r_1 and r_2, let angular velocities be ω_1 and ω_2 respectively

$$\therefore \quad \frac{r_2}{r_1} = \frac{\omega_1^2}{\omega_2^2} = \left(\frac{\omega_1}{\omega_2}\right)^2$$

Given, $r_1 = 4r$, when $\omega_1 = \omega$ and for r_2, $\omega_2 = 2\omega$

$$\therefore \quad \frac{r_2}{4r} = \left(\frac{\omega}{2\omega}\right)^2 = \frac{1}{4} \quad \therefore \quad r_2 = r$$

21. (b): Given : ${}^a\mu_w = \dfrac{4}{3}$; ${}^a\mu_g = \dfrac{3}{2}$; ${}^g\mu_w = ?$

${}^a\mu_w \times {}^w\mu_g = {}^a\mu_g$

CONCEPT MAP

ESSENTIALS OF CHEMISTRY

Some important formulae, trends and terms for a 'quick recap'. **Class XI**

Physical Chemistry

Some Basic Concepts of Chemistry

- Atomic mass ; $\dfrac{\text{Average mass of an atom}}{\frac{1}{12}\times\text{Mass of an atom of C-12}}$
- Number of gram atoms = $\dfrac{\text{Mass of an element}}{\text{Gram atomic mass}}$
- Atomic mass = 6.4/Specific heat (cal/g)
- Gram molar volume = 22.4 L
- Molecular mass = 2 × Vapour density
- Molarity = No. of moles/Volume (L)
- Normality = No. of gram equivalents/Volume (L)
- % of an element = $\dfrac{\text{O cuu'qh'vj g''gno gpv}}{\text{Molecular mass}}\times 100$

Structure of Atom

- $E=h\upsilon=\dfrac{hc}{\lambda}=\dfrac{1}{\lambda}=\bar{\upsilon}=R\left(\dfrac{1}{n_1^2}-\dfrac{1}{n_2^2}\right)\ \text{cm}^{+1}$; mvr ; $\dfrac{nh}{2\pi}$
- r_n ; $\dfrac{n^2}{Z}\times 0.529\,\text{Å}$; $E_n=\dfrac{+Z^2}{n^2}\times 13.6$ eV per atom
- v_n ; $\dfrac{Z}{n}\times 2.188\times 10^8$ cm/s; $P.E.=\dfrac{+kZe^2}{r}$
- $K.E.$; $\dfrac{1}{2}\dfrac{kZe^2}{r}$; $Bx\cdot\Delta p\geq\dfrac{h}{4\pi}$

Chemical Bonding

- Ionic potential ; $\dfrac{\text{Charge on cation}}{\text{Size of cation}}$
- % of ionic character = $16(\chi_A-\chi_B)+3.5(\chi_A-\chi_B)^2$
- Dipole moment, $\mu=q\times d$
- % of ionic character = $\dfrac{\mu_{\text{observed}}}{\mu_{\text{theoretical}}}\times 100$

States of Matter

- $P_1V_1=P_2V_2$; $\dfrac{V_3}{T_1}=\dfrac{V_2}{T_2}$; $\dfrac{P_1}{T_1}=\dfrac{P_2}{T_2}$; $\dfrac{V_1}{n_1}$; $\dfrac{V_2}{n_2}$; $PV=nRT$
- $d=\dfrac{PM}{RT}=\dfrac{r_3}{r_2}=\sqrt{\dfrac{M_2}{M_1}}=\sqrt{\dfrac{d_2}{d_1}}$; $K.E.$; $\dfrac{3}{2}kT$
- $c_{rms}=\sqrt{5RT/M}$; $c_{mp}=\sqrt{2RT/M}$; $c_{av}=\sqrt{8RT/\pi M}$
- $T_b=a/Rb$; $T_c=8a/27Rb$; $P_c=a/27b^2$; $V_c=3b$
- Z ; $\dfrac{PV_m}{nRT}$; $P_cV_c=\dfrac{5}{8}RT_c$; $\left(P+\dfrac{n^2a}{V^2}\right)(V-nb)=nRT$

Thermodynamics

- $w_{irr}=-P\Delta V$
- w_{rev} ; $-2.303nRT\log\dfrac{V_2}{V_1}=-2.303nRT\log\dfrac{P_1}{P_2}$
- $\Delta H=\Delta E+\Delta n_gRT$; $C_v=\left(\dfrac{''E}{\partial T}\right)_V$; $C_p=\left(\dfrac{\partial H}{\partial T}\right)_p$
- $\log\dfrac{P_2}{P_1}=\dfrac{BH_{vap}}{2.303R}\left(\dfrac{T_2-T_1}{T_1T_2}\right)$
- $\Delta S=2.303nR\log\left(\dfrac{V_4}{V_1}\right)$; $\Delta G=\Delta H-T\Delta S$
- $\Delta G^\circ=-2.303\,RT\log K$

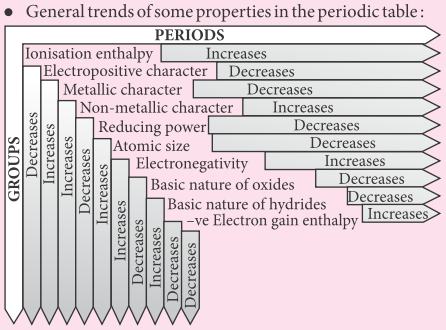
Equilibrium

- $\dfrac{k_f}{k_b}$; $K_c=\dfrac{[C]^c[D]^d}{[A]^a[B]^b}$; $K_p=\dfrac{p_C^cp_D^d}{p_A^ap_B^b}$; $K_p=K_c(RT)^{\Delta n}$
- $\log\dfrac{K_4}{K_1}=\dfrac{\Delta H}{2.303R}\left(\dfrac{T_2-T_1}{T_1T_2}\right)$; $K=\dfrac{C\alpha^4}{1-\alpha}=C\alpha^2$
- $K_w=K_a\times K_b$; $K_{sp}=[A^{y+}]^x\cdot[B^{x-}]^y$
- pH $=pK_a+\log\dfrac{]\text{Ucnv}}{[\text{Acid}]}$; pOH ; $pK_b+\log\dfrac{[\text{Salt}]}{[\text{Base}]}$
- pH ; $\dfrac{1}{2}[pK_w-pK_b-\log C]$ (for salt of strong acid and weak base)
- pH $=\dfrac{3}{2}[pK_w+pK_a-pK_b]$ (for salt of weak acid and weak base)
- pH ; $\dfrac{1}{2}[pK_w+pK_a+\log C]$ (for salt of weak acid and strong base)

Inorganic Chemistry

Classification of Elements and Periodicity in Properties

- General trends of some properties in the periodic table :



Redox Reactions

- **Oxidation :** Addition of O or electronegative element; Removal of H or electropositive element; Loss of e's; increase in O. No.
- **Reduction :** Addition of H or electropositive element; Removal of O or electronegative element; Gain of e's; decrease in O. No.
- **Redox reactions :** Oxidation and reduction occur simultaneously.
- **Oxidising agent :** Oxidises others and itself gets reduced.
- **Reducing agent :** Reduces others and itself gets oxidised.

Hydrogen

- Strength of 10 vol. of H_2O_2 solution = 30.35 g/L
- Volume strength = 5.6 × Normality
- Volume strength = 11.2 × Molarity
- **Ortho hydrogen :** Parallel nuclear spins; total nuclear spin = + 1/2 + 1/2 = 1
- **Para hydrogen :** Antiparallel nuclear spins; total nuclear spin = + 1/2 – 1/2 = 0

The *s*- and *p*-Block Elements

- **Basic strength :** LiOH < NaOH < KOH < RbOH < CsOH
  - $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$
  - $B(OH)_3 < Al(OH)_3 < Ga(OH)_3 < In(OH)_3 < Tl(OH)_3$
- **Stability :** $Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$
  - $BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$
  - $BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$
- **Solubility :** $BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$
  - $BeSO_4 > MgSO_4 > CaSO_4 > \underbrace{SrSO_4 > BaSO_4}_{\text{Almost insoluble}}$
  - $BeC_2O_4 > \underbrace{CaC_2O_4 < SrC_2O_4 < BaC_2O_4}_{\text{Sparingly soluble in water}}$
- **Stability of oxidation states :**
  - $B^{3+} > Al^{3+} > Ga^{3+} > In^{3+} > Tl^{3+}$
  - $B^{+} < Al^{+} < Ga^{+} < In^{+} < Tl^{+}$
  - $Ge^{4+} > Sn^{4+} > Pb^{4+}$
  - $Ge^{2+} < Sn^{2+} < Pb^{2+}$
- **Lewis acid character :**
  - $BX_3 > AlX_3 > GaX_3 > InX_3$
  - $BF_3 < BCl_3 < BBr_3 < BI_3$
- **Catenation tendency :** C >> Si > Ge ≈ Sn >> Pb
- **Acidic strength :**

$\underbrace{CO_2}_{\text{Acidic}} > \underbrace{SiO_2}_{\text{Less acidic}} > \underbrace{GeO_2 > SnO_2 > PbO_2}_{\text{Amphoteric}}$

Acids and Bases

- **Lewis acid :** An electron pair acceptor
- **Lewis base :** An electron pair donor.
- **Arrhenius acid :** Gives H^+ ion in aq. solution.
- **Arrhenius base :** Gives OH^- ion in aq.solution.
- **Bronsted acid :** Proton donor
- **Bronsted base :** Proton acceptor

Environmental Chemistry

- **Classical smog:** Reducing smog, occurs in cool and humid climate, mixture of smoke, fog and sulphur dioxide.
- **Photochemical smog:** Oxidising smog, occurs in warm, dry and sunny climate, mixture of nitrogen oxides and volatile organic compounds.
- **International standard for drinking water :**
  F^- – 1 ppm; SO_4^{2-} – < 500 ppm
  Pb – 50 ppb; NO_3^- – 50 ppm; pH – 5.5 - 9.5

Organic Chemistry

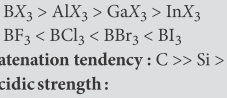
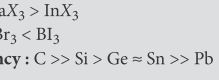
Some Basic Principles and Techniques

- **Preference order of functional groups :** Carboxylic acids > sulphonic acids > anhydrides > esters > acid chlorides > acid amides > nitriles > isocyanides > aldehydes > ketones > alcohols > phenols > thiols > amines > alkenes > alkynes
- **Stability order :**
  Carbocations : $3^\circ > 2^\circ > 1^\circ > \overset{+}{C}H_3$
  Carbanions : $\bar{C}H_3 > 1^\circ > 2^\circ > 3^\circ$
  Free radicals : $3^\circ > 2^\circ > 1^\circ > \dot{C}H_3$
- **–*I* effect :** $-NO_2 > -CN > -COOH > -F > -Cl > -Br > -I > -H$
- **+*I* effect :** $(CH_3)_3C- > (CH_3)_2CH- > CH_3CH_2- > CH_3- > D- > H-$
- **+*R* effect :** $-OH$, $-OR$, $-SH$, $-SR$, $-NH_2$, $-NHR$, $-NR_2$, $-Cl$, $-Br$, $-I$
- **–*R* effect :** $>C=O$, $-CHO$, $-COOR$, $-CN$, $-NO_2$

Quantitative Estimation

- **Liebig's combustion method :**
  % of C ; $\dfrac{12}{44}\times\dfrac{\text{Mass of } CO_2 \text{ formed}}{\text{Mass of compound taken}}\times 100$
  % of H ; $\dfrac{2}{18}\times\dfrac{\text{Mass of } H_2O \text{ formed}}{\text{Mass of compound taken}}\times 100$
- **Dumas method :**
  % of N = $\dfrac{28}{22400}\times\dfrac{\text{Vol. of } N_4 \text{ at STP}}{\text{Wt. of compound}}\times 100$
- **Kjeldahl's method :**
  % of N = $\dfrac{1.4\times M_{ccid}\times V_{acid}\times\text{Basicity of acid}}{\text{Wt. of compound}}$
- **Carius method :**
  ' "qh'X
  $=\dfrac{\text{At. wt. of } X}{108+\text{At. wt. of } X}\times\dfrac{\text{Wt. of AgX formed}}{\text{Wt. of compound}}\times 100$
  % of S = $\dfrac{32}{233}\times\dfrac{\text{Wt. of } BaSO_6 \text{ formed}}{\text{Wt. of compound}}\times 100$
- **Ignition method :**
  % of P = $\dfrac{62}{222}\times\dfrac{\text{Wt. of } Mg_4P_4O_9 \text{ formed}}{\text{Wt. of compound}}\times 100$
- **Iodine method :**
  % of O = $\dfrac{32}{88}\times\dfrac{\text{Wt. of } CO_4 \text{ formed}}{\text{Wt. of compound}}\times 100$

Hydrocarbons

- **Conformations of ethane :**
  Staggered > Skew or Gauche > Eclipsed
- **Conformations of cyclohexane :**
  Chair > Twist-boat > Boat > Half-chair
- **Stability order of different alkenes :**
  $R_2C=CR_2 > R_2C=CHR > R_2C=CH_2 >$  $>$  $> RCH=CH_2 > CH_2=CH_2$
- ***o*-,*p*-directing groups :**
  $-R$, $-OH$, $-SH$, $-NH_2$, $-O^-$, $-OR$, $-NHR$, $-NR_2$, $-NHCOR$, $-Cl$, $-Br$, $-I$, $-CH_2Cl$, $-CH_2OH$, $-CH_2NH_2$, $-CH_2CN$, $-CH_2COOH$, $-CH=CH_2$, $-CH=CHCOOH$, $-C_6H_5$, $-N=N$, $-NC$, etc.
- ***m*-directing groups :**
  $-SO_3H$, $-NO_2$, $-CHO$, $-COOH$, $-CN$, $-NH_3Cl$, $-SO_2Cl$, $-COCl$, $-COOR$, $-COR$, $-CONH_2$, $-CCl_3$, $-CF_3$, $-\overset{+}{N}H_3$, $-\overset{+}{N}H_2R$, $-\overset{+}{N}HR_2$, $-\overset{+}{N}R_3$, etc.
- **Aromatic compounds :** Cyclic, completely conjugated system of *p*-orbitals in ring, planar, $(4n+2)\pi$-*e*'s.
- **Anti-aromatic compounds :** Cyclic, completely conjugated system of *p*-orbitals in ring, planar, $4n$ π-*e*'s.
- **Non-aromatic compounds :** Does not satisfy any one or more of the above conditions.

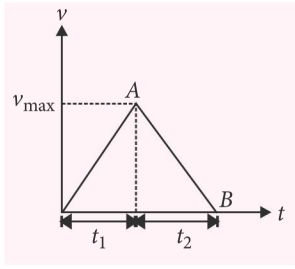
or $${}^{w}\mu_g = \frac{{}^{a}\mu_g}{{}^{a}\mu_w} = \frac{3/2}{4/3} = \frac{9}{8}$$

$${}^{g}\mu_w = \frac{1}{{}^{w}\mu_g} = \frac{1}{(9/8)} = \frac{8}{9}$$

22. (c) : Let the car accelerates for time t_1 and decelerates for time t_1. Then,

$t = t_1 + t_2$ ...(i)

and corresponding velocity-time graph will be as shown in figure.



From the graph,

α = slope of line $OA = \frac{v_{max}}{t_1}$

or $t_1 = \frac{v_{max}}{\alpha}$ ...(ii)

and β = slope of line $AB = \frac{v_{max}}{t_2}$

or $t_2 = \frac{v_{max}}{\beta}$ ...(iii)

From Eqs. (i), (ii) and (iii), we get

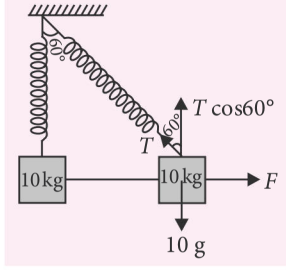
$$t = \frac{v_{max}}{\alpha} + \frac{v_{max}}{\beta}$$

or $$t = v_{max}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right) \text{ or } t = v_{max}\left(\frac{\alpha+\beta}{\alpha\beta}\right)$$

or $$v_{max} = \frac{\alpha\beta t}{\alpha+\beta}$$

23. (a)

24. (a) : The situation is shown in figure.



$T\cos\theta = 10g$

$$= \frac{10g}{\cos 60^\circ}$$

$= 20g$

= 20 kg wt

25. (b) : Potential energy lost by the mass falling through a distance $(h + d) = mg(h + d)$

Potential energy stored in the spring $= \frac{1}{2}kd^2$

Net work done in the process is

$$= mg(h + d) - \frac{1}{2}kd^2$$

26. (c) : According to Einstein's photoelectric equation

$$eV = \frac{hc}{\lambda} - \phi_0$$

Where, V = Stopping potential

λ = Incident wavelength

ϕ_0 = Work function

$$\therefore \quad V = \left(\frac{h}{e}\right)\frac{c}{\lambda} - \frac{\phi_0}{e}$$

$$V_1 = \left(\frac{h}{e}\right)\frac{c}{\lambda_1} - \frac{\phi_0}{e} \quad \text{...(i)}$$

$$V_2 = \left(\frac{h}{e}\right)\frac{c}{\lambda_2} - \frac{\phi_0}{e} \quad \text{...(ii)}$$

Solving these two equations, we get

$$\frac{h}{e} = \frac{\lambda_1\lambda_2(V_1 - V_2)}{c(\lambda_2 - \lambda_1)}$$

$$= \frac{(0.6\times0.4\times10^{-12})(1.0)}{(3\times10^{8})(0.2\times10^{-6})} = 4\times10^{-15} \text{ V s}$$

27. (b) : Here, real depth of mark, $x = 3$ cm

apparent depth of mark, y = ?

refractive index, $\mu = 1.5$

As $\mu = \frac{x}{y}$ $\quad \therefore \quad y = \frac{x}{\mu} = \frac{3}{1.5} = 2$ cm

Distance through which mark appears to be raised $= x - y = 3 - 2 = 1$ cm

$\therefore$ To get the mark in focus again, distance through which microscope be moved upwards = 1 cm.

28. (b) : Here, diameter of the hose, $D = 2.0$ cm,

Speed of water in the hose, $V = 90.0$ cm s^{-1},

Diameter of each hole, $d = 0.125$ cm

number of holes, $n = 24$

Let v be the velocity of water flowing out of each hole. Volume of the water crossing hose per second is equal to the volume of the water leaving out per second through holes. So

$$\frac{\pi D^2}{4}\times V = n\frac{\pi d^2}{4}\times v$$

or $$v = \frac{D^2V}{nd^2} = \frac{(2 \text{ cm})^2\times90.0 \text{ cm s}^{-1}}{24\times(0.125 \text{ cm})^2} = 960 \text{ cm s}^{-1}$$

29. (d) : For a transistor, $\Delta I_E = \Delta I_B + \Delta I_C$

$$\alpha = \frac{\Delta I_C}{\Delta I_E} \quad \therefore \quad \alpha = \frac{\Delta I_C}{\Delta I_B + \Delta I_C}$$

Substituting the values, we get

$$0.9 = \frac{\Delta I_C}{4 + \Delta I_C} \text{ or } \Delta I_C = 36 \text{ mA}$$

30. (d) : For the first case, $m = -3$

$\because \quad m = -\frac{v}{u} = -3$ (As the image is real)

$\therefore \quad v = 3u$

Here, $u = -x$ $\quad\therefore\quad v = -3x$

According to mirror formula

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$

$$\therefore \quad \frac{1}{(-x)}+\frac{1}{(-3x)}=\frac{1}{f} \qquad \ldots(i)$$

For the second case, $m = -2$

$$\because \quad m=-\frac{v}{u}=-2$$

$$\therefore \quad v = 2u$$

Here, $u = -(x+5) \quad \therefore \quad v = -2(x+5)$

Using mirror formula

$$\frac{1}{-(x+5)}+\frac{1}{-2(x+5)}=\frac{1}{f} \qquad \ldots(ii)$$

Solving (i) and (ii), we get $f = -30$ cm

31. (a) : The magnetic field at the centre of a current carrying loop is given by

$$B=\frac{\mu_0}{4\pi}\left(\frac{2\pi I}{a}\right)=\frac{\mu_0 I}{2a}$$

The magnetic moment at the centre of current carrying loop is given by

$$M = I(\pi a^2)$$

Thus, $\frac{B}{M}=\frac{\mu_0 I}{2a}\times\frac{1}{I\pi a^2}=\frac{\mu_0}{2\pi a^3}=x$ (Given)

When both the current and the radius are doubled, the ratio becomes

$$\frac{\mu_0}{2\pi(2a)^3}=\frac{\mu_0}{8(2\pi a^3)}=\frac{x}{8}$$

32. (d): For an adiabatic process,

$$T^{\gamma}P^{1-\gamma} = \text{constant} \implies P \propto T^{\gamma/(\gamma-1)}$$

Comparing above equation with given equation

$$P \propto T^{c}$$

$$\Rightarrow \quad c=\frac{\gamma}{\gamma-1}=\frac{\frac{5}{3}}{\frac{5}{3}-1}=\frac{5}{2} \text{ (For monoatomic gas, } \gamma=\frac{5}{3})$$

33. (b): Time period of suspended magnet

$$T=2\pi\sqrt{\frac{I}{MB\cos\delta}}, \quad \upsilon=\frac{1}{2\pi}\sqrt{\frac{MB\cos\delta}{I}}$$

For the same value of M, I

$$\upsilon \propto \sqrt{B\cos\delta} \quad \text{or} \quad B \propto \frac{\upsilon^2}{\cos\delta}$$

$$\therefore \quad \frac{B_1}{B_2}=\frac{400}{\cos 30^\circ}\times\frac{\cos 60^\circ}{225}$$

$$=\frac{16\times 2}{9\times\sqrt{3}}\times\frac{1}{2}=16:9\sqrt{3}$$

34. (c) : Number of atoms remained undecayed after time t, is $N = N_0 e^{-\lambda t}$

$$\therefore \quad -\lambda t=\ln\frac{N}{N_0} \text{ or } \lambda t=\ln\left(\frac{N_0}{N}\right)$$

$$\text{or} \quad t=\frac{1}{\lambda}\ln\left(\frac{N_0}{N}\right) \qquad \ldots(i)$$

Here, $N=\frac{3N_0}{100}$, $\lambda=\frac{0.693}{T_{1/2}}=\frac{0.693}{2}=0.3465$

$$\therefore \quad t=\frac{1}{0.3465}\ln\left(\frac{100}{3}\right)=10 \text{ yr}$$

35. (d): Net pulling force = $2g - 1g = 1g = 10$ N

Mass being pulled = 2 + 1 = 3 kg

$\therefore$ Acceleration of the system is $a = \frac{10}{3}$ m s^{-2}

$\therefore$ Velocity of both the blocks at $t = 1$ s will be

$$v = at = \left(\frac{10}{3}\text{ m s}^{-2}\right)(1\text{ s}) = \frac{10}{3}\text{ m s}^{-1}$$

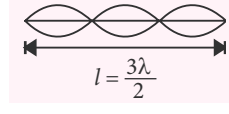
Now, at this moment velocity 2 kg block becomes zero, while that of 1 kg block is $\frac{10}{3}$ m s^{-1} upwards. Hence, string becomes tight again when,

Displacement of 1 kg block = Displacement of 2 kg block

$$\text{or} \quad vt-\frac{1}{2}gt^2=\frac{1}{2}gt^2 \quad \text{or} \quad t=\frac{v}{g}=\frac{\frac{10}{3}\text{ m s}^{-1}}{10\text{ m s}^{-2}}=\frac{1}{3}\text{ s}$$

36. (d): Wave number,

$$k=\frac{2\pi}{\lambda}=0.6\text{ cm}^{-1}$$



$$\therefore \quad \frac{\lambda}{2}=\frac{\pi}{0.6}\text{ cm}$$

$$\text{or} \quad l=\frac{3\lambda}{2}=3\left(\frac{\pi}{0.6}\right)\text{cm}=15.7\text{ cm}$$

37. (c) : For an adiabatic process $dQ = 0$

From the first law of thermodynamics, we get

$$0 = dU + PdV$$

From the given equation

$$dU = 3(PdV + VdP)$$

$\therefore \quad 0 = 3(PdV + VdP) + PdV$

or $\quad 4P(dV) + 3V(dP) = 0$

$$\text{or} \quad 4\left(\frac{dV}{V}\right)=-3\left(\frac{dP}{P}\right)$$

On integrating, we get

$\ln(V^4) + \ln(P^3) = \text{constant}$

or $PV^{4/3} = \text{constant}$

Compare it with standard equation of an adiabatic process $PV^{\gamma} = \text{constant}$, we get $\gamma = \frac{4}{3}$

i.e., gas is polyatomic.

38. (c) : When the object is placed at the centre of the glass sphere, the rays from the object fall normally on the surface of the sphere and emerge undeviated.

Hence the image will be formed at the centre itself.

$\therefore$ Distance of virtual image from surface = 6 cm.

39. (b) : Electrostatic force, $F_e = eE$ (for both the particles)

But acceleration of electron, $a_e = F_e/m_e$ and acceleration of proton, $a_p = F_e/m_p$

$$S = \frac{1}{2}a_e t_1^2 = \frac{1}{2}a_p t_2^2 \quad \therefore \quad \frac{t_2}{t_1} = \sqrt{\frac{a_e}{a_p}} = \sqrt{\frac{m_p}{m_e}}$$

40. (d)

41. (b) : Kinetic energy, $\text{KE} = \frac{GMm}{2r}$

Potential energy, $\text{PE} = \frac{GMm}{r}$

Total energy, $\text{TE} = -\frac{GMm}{2r}$

$\therefore$ KE is always positive and $\text{KE} \propto \frac{1}{r}$

PE is always negative and $|\text{PE}| \propto \frac{1}{r}$

TE is also negative and $|\text{TE}| \propto \frac{1}{r}$.

Also $|\text{TE}| < |\text{PE}|$

Thus the curve *A* represents KE, curve *B* represents PE and curve *C* represents TE of the satellite.

42. (a) : Let θ be angle between $\vec{A}$ and $\vec{B}$.

$\therefore$ Resultant of $\vec{A}$ and $\vec{B}$ is

$$P = \sqrt{A^2 + B^2 + 2AB\cos\theta} \qquad \ldots(i)$$

When $\vec{B}$ is reversed, then the angle between $\vec{A}$ and $-\vec{B}$ is $(180° - \theta)$.

$\therefore$ Resultant of $\vec{A}$ and $-\vec{B}$ is

$$Q = \sqrt{A^2 + B^2 + 2AB\cos(180° - \theta)}$$

$$Q = \sqrt{A^2 + B^2 - 2AB\cos\theta} \qquad \ldots(ii)$$

Squaring and adding (i) and (ii), we get

$P^2 + Q^2 = 2(A^2 + B^2)$

43. (c) : For a simple harmonic motion, $x = A\sin\omega t$

The kinetic energy is given by

$$K = \frac{1}{2}m\omega^2 A^2\cos^2\omega t = \frac{1}{2}m\omega^2 A^2(1 - \sin^2\omega t)$$

$$K = \frac{1}{2}m\omega^2 A^2 - \frac{1}{2}m\omega^2 x^2 = \frac{1}{2}m\omega^2(A^2 - x^2)$$

The total energy is given by $E = \frac{1}{2}m\omega^2 A^2$

Given : $K = \frac{E}{4}$ or $4K = E$

$$4 \times \frac{1}{2}m\omega^2(A^2 - x^2) = \frac{1}{2}m\omega^2 A^2$$

or $4A^2 - 4x^2 = A^2$ or $4x^2 = 3A^2$ or $x = \frac{\sqrt{3}}{2}A$

44. (c) : Here, $R = X_L = X_C$

($\because$ voltage across them is same)

Total voltage in the circuit,

$V = I[R^2 + (X_L - X_C)^2]^{1/2} = IR = 10$ V

When capacitor is short circuited,

$$I' = \frac{10}{(R^2 + X_L^2)^{1/2}} = \frac{10}{\sqrt{2}R}$$

$\therefore$ Potential drop across inductance

$$= I'X_L = I'R = \frac{10}{\sqrt{2}} \text{ V}$$

45. (a)

46. (a) : $\frac{\bar{\nu}_{He}}{\bar{\nu}_{O_2}} = \sqrt{8}$ (given)

$$\frac{\sqrt{\left(\frac{8RT}{\pi M}\right)_{He}}}{\sqrt{\left(\frac{8RT}{\pi M}\right)_{O_2}}} = \sqrt{8} \quad \Rightarrow \quad \frac{\sqrt{\frac{T_{He}}{4}}}{\sqrt{\frac{T_{O_2}}{32}}} = \sqrt{8}$$

$$\Rightarrow \quad \sqrt{\frac{8T_{He}}{T_{O_2}}} = \sqrt{8} \quad \Rightarrow \quad T_{He} = T_{O_2}$$

47. (c) : $\overset{1}{\text{CH}_3}-\overset{*2}{\underset{\text{Cl}}{\text{CH}}}-\overset{3}{\text{CH}_2}-\overset{*4}{\underset{\text{Cl}}{\text{CH}}}-\overset{5}{\text{CH}_2}-\overset{6}{\text{CH}_2}-\overset{7}{\text{CH}_3}$

(2, 4-dichloroheptane)

Total no. of stereoisomers = $2^n = 2^2 = 4$ where, *n* is the no. of asymmetric carbon atoms.

48. (c) : $N_{(g)} + e^- \longrightarrow N^-_{(g)}$; $\Delta_{eg}H^\circ$ = +ve

This is due to exactly half-filled electronic configuration of N ($2s^2 2p^3$).

49. (c) : The strength of the solution is 0.1 N.

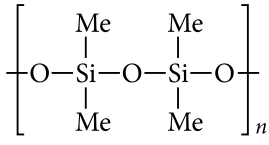
$$\frac{w}{E} = \frac{V \times N}{1000} \qquad (\because \text{ eq. wt.} = \frac{200}{2} = 100)$$

$$\Rightarrow \quad w = \frac{100 \times 0.1 \times 100}{1000} = 1 \text{ g}$$

50. (a)

51. (c) : $Me_2SiCl_2 \xrightarrow[-HCl]{+H_2O} Me_2Si(OH)_2 \xrightarrow{H_2O}$

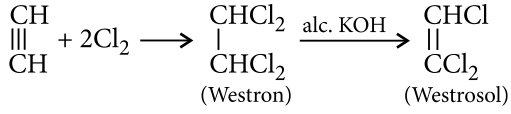
Dimethyldihydrosilane



Silicone

52. (d): It is uncertainty principle and not Bohr's postulate.

53. (a) :

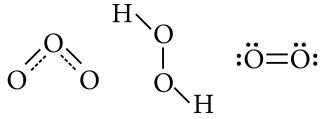


(Westron) (Westrosol)

54. (a) : $H_2O_{(g)} + C_{(s)} \xrightarrow[Ni]{1270\ K} \underbrace{H_{2(g)} + CO_{(g)}}$

Steam Red hot coke Water gas

55. (b):



(128 pm) (147.5 pm) (120 pm)

Therefore, O — O bond length increases in the order : $O_2 < O_3 < H_2O_2$.

56. (c) : *Ortho* and *para*-nitrophenols differ in their boiling points, which can be separated from each other by distillation. Due to intramolecular H-bonding in *o*-nitrophenol, its boiling point is lower than *p*-nitrophenol in which intermolecular H-bonding exists.

57. (d): Oxides of *d*-block elements in oxidation states +5, +6 and +7 are acidic.

Oxides of chromium :

	CrO	Cr_2O_3	CrO_2	CrO_3
O.N.	+2	+3	+4	+6
	Basic	Amphoteric		Acidic

Acidic character increases

58. (c) : 1 mole of M_2O_x on reduction gives 2 g-atoms of *M*.

i.e., $(2 \times 56 + 16x)$g of M_2O_x gives $2 \times 56 = 112$ g of *M*.

$\therefore$ 4 g of M_2O_x will give $\frac{112}{112+16x} \times 4$ g of *M*

$\therefore \quad \frac{112 \times 4}{112+16x} = 2.8$

$\Rightarrow \quad 448 = 2.8(112 + 16x)$

$\Rightarrow \quad x = 3$

59. (d): $C_2H_5NH_2 + CS_2 + HgCl_2 \xrightarrow{\Delta}$

$C_2H_5N = C = S + HgS + 2HCl$

Ethyl isothiocyanate

60. (b):

$K_3[Fe(CN)_6]$	:	Paramagnetic (one unpaired electron)
$K_2[NiCl_4]$	:	Paramagnetic (two unpaired electrons)
$K_2[CoCl_4]$	:	Paramagnetic (three unpaired electrons)
$Na_2[Ni(CN)_4]$	:	Diamagnetic (zero unpaired electrons)

61. (c)

62. (c) : $(-CH_2-\underset{\underset{Cl}{|}}{C}=CH-CH_2-)_n$ is fire resistant

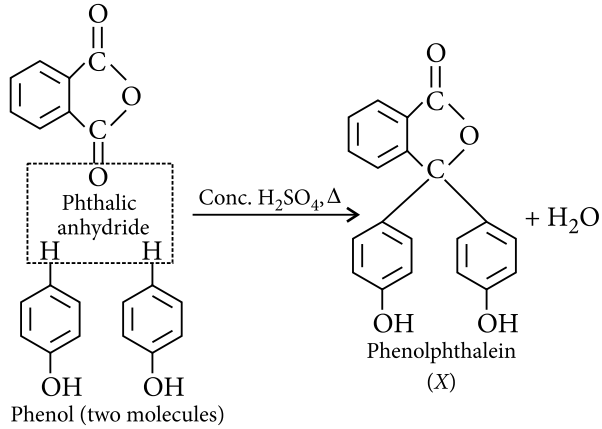
(neoprene or duprene)

rubber and is used to make lining of containers for storing organic chemicals.

63. (b): $Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$

Base (strong) Acid (weak)

64. (c) : The product '*X*' is phenolphthalein that gives pink colour with NaOH.



Phthalic anhydride

Phenol (two molecules)

Phenolphthalein (*X*)

65. (d): Order of electron gain enthalpy is Cl > F > Br > I.

66. (b): $HgCl_2 \rightleftharpoons Hg^{2+} + 2Cl^-$

$K_{sp} = s \times (2s)^2 = 4s^3$ [*s* is solubility]

$4s^3 = 4 \times 10^{-15}$

$\Rightarrow \quad s = 10^{-5}$

$[Cl^-] = 2s = 2 \times 10^{-5}$ M

67. (b): $\Delta G = \Delta H - T\Delta S$

At 1000 K,

$\Delta G = -283 \text{ kJ} - 1000 \text{ K} \times \left(\frac{-97}{1000} \text{kJ}\right) = -186 \text{ kJ}$

At 1500 K,

$\Delta G = -283 \text{ kJ} - 1500 \text{ K} \times \left(\frac{-97}{1000} \text{kJ}\right) = -137.5 \text{ kJ}$

At 3000 K,

$\Delta G = -283 \text{ kJ} - 3000 \text{ K} \times \left(\frac{-97}{1000} \text{kJ}\right) = +8.0 \text{ kJ}$

At 3500 K,

$\Delta G = -283 \text{ kJ} - 3500 \text{ K} \times \left(\frac{-97}{1000} \text{kJ}\right) = +56.5 \text{ kJ}$

Thus, at 1000 K and at 1500 K, the reaction will be spontaneous.

68. (a): Rate of S_N1 reaction depends on dielectric constant as carbocation is formed in S_N1 mechanism. Medium having high dielectric constant are better ionising solvents.

69. (c): The tendency to exist in 8-atoms ring is greatest with sulphur and decreases as we go down the group. This is due to the decrease in the single bond energy values between the two similar atoms.

70. (b): Intercept, $\log k = 0.301$

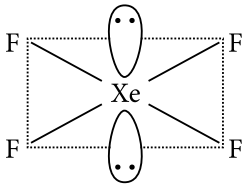
$\Rightarrow \quad k = \text{Antilog } 0.301 = 2$

Slope of the graph, $\frac{1}{n} = 1$

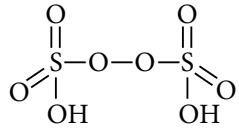
So, $\frac{x}{m} = kP^{1/n} = 2 \times (0.2)^1 = 0.4$

71. (d): Elements which are used as semiconductors such as Si, Ge, Ga, etc. are refined by this method, which is based on the difference in solubility of impurities in molten and solid state of the metal.

72. (a): In XeF_4, the Xe atom is sp^3d^2 hybridised, which contains two lone pairs and four bond pairs. Therefore, the shape of XeF_4 molecule is square planar, with one lone pair orbital over and other below the plane.

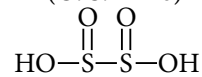


73. (c): $H_2S_2O_8$:



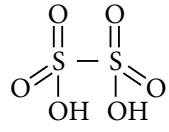
(O. S. = + 6)

$H_2S_2O_4$:



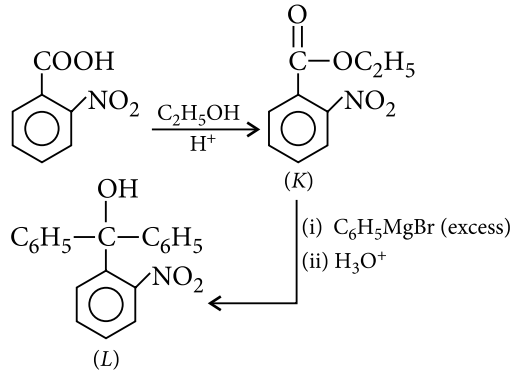
(O. S. = + 3)

$H_2S_2O_6$:



(O. S. = + 5)

74. (d):



75. (d)

76. (d): Given,

$XeF_6 + H_2O \rightleftharpoons XeOF_4 + 2HF; \; K_{eq} = K_1$

$XeOF_4 + 2HF \rightleftharpoons XeF_6 + H_2O; \; K_{eq} = 1/K_1$ …(i)

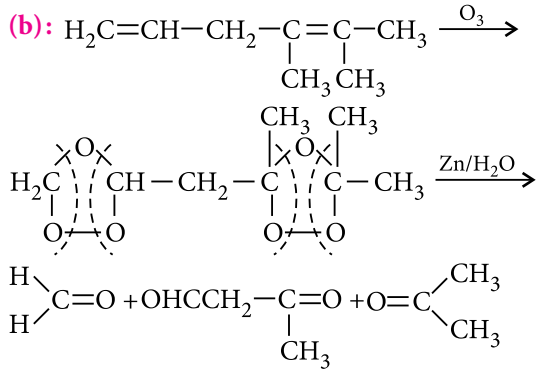
$XeO_4 + XeF_6 \rightleftharpoons XeOF_4 + XeO_3F_2; \; K_{eq} = K_2$ …(ii)

The reaction, $XeO_4 + 2HF \rightleftharpoons XeO_3F_2 + H_2O$, can be obtained by adding eq. (i) and eq.(ii).

So, the equilibrium constant for the said reaction can be obtained by multiplying the equilibrium constants of eq. (i) and eq. (ii).

Hence, the value is $\frac{K_2}{K_1}$.

77. (b):



78. (c)

79. (b): If atomic weight of Fe is x, then equivalent weights of Fe^{3+} and Fe^{2+} are $x/3$ and $x/2$ respectively.

$$W = ZIt$$

On passing the same current, say 1 F of charge through both the solutions for a given interval of time, the ratio of weights of iron deposited at cathodes will be $\frac{x}{3} : \frac{x}{2}$, *i.e.*, 2 : 3.

80. (c): pH of solution is above 7, *i.e.*, medium is alkaline. The alanine molecule at pH > 7, will exist as $H_2N-\underset{\displaystyle CH_3}{\underset{|}{CH}}-COO^-$.

81. (b): In $[Ni(CO)_4]$; Ni : $3d^8$ ↑↓ ↑↓ ↑↓ ↑ ↑ $4s^2$ ↑↓ shifts to $3d^{10}$ ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ acquiring sp^3 hybridisation as CO is a strong field ligand.

In $[Ni(CN)_4]^{2-}$; Ni^{2+} : $3d^8$ ↑↓ ↑↓ ↑↓ ↑ ↑ shifts to ↑↓ ↑↓ ↑↓ ↑↓ ☐ acquiring dsp^2 hybridisation as CN^- is a strong field ligand.

In $[NiCl_4]^{2-}$; Ni^{2+}: $3d^8$ ↑↓ ↑↓ ↑↓ ↑ ↑ acquires sp^3 hybridisation as Cl^- is a weak field ligand.

82. (a): $NH_3 + HCl \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl}$

Dalton's law of partial pressure is applicable only in those cases where gases are non-reacting.

83. (a): Higher the electronegativity of the group/atom having $-I$ effect, higher will the +ve charge on $\overset{*}{C}$-atom of the chain. Here, Cl and Br have $-I$ effect and Cl has higher electronegativity (3.2) than Br (2.8).

84. (d): Washing soda is $Na_2CO_3 \cdot 10H_2O$

85. (c): Along the period, as we move from Li → Be → B → C, the electronegativity increases and hence, the electronegativity difference between the element and Cl decreases and accordingly, the covalent character increases. Thus, the correct order is $LiCl < BeCl_2 < BCl_3 < CCl_4$.

86. (b): The esters having active methylene group (— CH_2 —), show Claisen condensation reaction. As $C_6H_5COOC_2H_5$ has no α-hydrogen atom or active methylene group, so it cannot undergo Claisen condensation reaction.

87. (a): Size of M^{3+} ions decreases on moving left to right in lanthanide series.

88. (d): Because C_2H_5I and C_2H_5OH have dissimilar interactions. The interactions between the components are different from those of the pure components.

89. (d)

90. (a): Oxidising nature : $F_2 > Cl_2 > Br_2 > I_2$

91. (d): The phylogenetic system of classification was put forth by Engler & Prantl in 1892. According to this system the families were arranged in accordance to the increasing complexity of the flower, fruit and seed development.

92. (d): Taxonomic keys are aids for rapid identification of unknown plants. Flora is an inventory of the plants of a defined geographical region. Herbarium is a safe place for storing specimens as well as provide suitable atmosphere for research. Monograph is a comprehensively taxonomic treatment of a taxonomic group, generally a genus or a family, providing all taxonomic data relating to that group.

93. (b): Whittaker's system is based on the following three criteria:

- Complexity of cell structure.
- Complexity of the body organization.
- Mode of nutrition.

On the basis of these criteria, Whittaker divided organisms into five kingdoms. These five Kingdoms are Monera, Protista, Algae, Fungi and Animalia.

94. (d)

95. (b) :

Cup shaped	-	*Chlamydomonas*
Girdle shaped	-	*Ulothrix*
Stellate	-	*Zygnema*
Reticulate	-	*Oedogonium*

96. (a): *Equisetum* is commonly called scouring rushes or horse tail.

97. (b): Annelids are triploblastic, bilaterally symmetrical, coelomate segmented animals with organ system level of organization. Excretory organs are nephridia. Phylum Arthropoda includes animals with jointed appendages. Their body is segmented. Excretion is brought about by green glands in aquatic forms and malphigian tubules in terrestrial animals.

98. (b)

99. (d): Tendons and ligaments are the modifications of white fibrous tissue and yellow elastic connective

tissues respectively. Fibrous connective tissue is a type of connective tissue which has relatively high tensile strength. Such tissues form ligaments and tendons.

100. (b)

101. (d) : Verticillaster is a special type of cymose inflorescence found in many plants belonging to family Labiatae. In this inflorescence, receptacle is flattened at the top and bears numerous sessile flowers in centripetal order.

102. (a)

103. (b) : In some plants the stem is feeble or weak and aerial part of it grows horizontally on the ground while some part remains underground. They may be of different kinds like runner, stolon, sucker and offset. Aerial branches are formed from the axil of scaly leaves which are present on the nodes while the roots arise from the lower side. *e.g. Cynodon*, *Hydrocotyle*, *Oxalis*.

104. (b) **105. (d)**

106. (c) : Leucoplast are colourless plastids which generally occur near the nucleus in non green cells and possess internal lamellae. It is of three types - amyloplast, proteinoplast and elaioplast. Amyloplasts can synthesize and store starch. Proteinoplasts store proteins but can not synthesize. Elaioplasts store lipids.

107. (c) : Lysine is basic amino acid.

108. (a) **109. (c)**

110. (c) : Howard and Pelc divided the cell cycle into four successive intervals: G_1, S-phase, G_2, and mitosis. G_1 is the period between the end of mitosis and the start of DNA synthesis, S is the period of DNA synthesis, and G_2, the interval between the end of DNA synthesis and the start of mitosis. During G_2 a cell contains two times (4C) the amount of DNA present in the original diploid cell (2C). Following mitosis the daughter cells again enter the G_1-period and have a DNA content equivalent to 2C.

111. (b)

112. (b) : Water potential is the difference in chemical potential of water in a system over its pure state at the same temperature and pressure. It has a negative value and is denoted by Ψ_w.

$$\Psi_w = \Psi_s + \Psi_p$$

Ψ_s is solute potential and Ψ_p is pressure potential. Matric potential (Ψ_m) has a negative value and decreases water potential. It is reduction in free energy of water when the latter comes to form their surface layers absorbed over colloidal particles. So, the relationship of water potential of a plant cell is $\Psi_w = \Psi_m + \Psi_s + \Psi_p$.

113. (d)

114. (b) : Carbon, oxygen and hydrogen are called the framework elements as all the components of a living organism contain C, H and O particularly the carbohydrates, proteins, lipids and nucleic acids. The three elements are taken up by the plant in the form of CO_2 and H_2O.

115. (b) **116. (b)** **117. (d)**

118. (b) :

4C compound	-	Malic acid
2C compound	-	Acetyl CoA
5C compound	-	α-Ketoglutaric acid
3C compound	-	Pyruvate

119. (c)

120. (a) : In Krebs' cycle the first step is the formation of citric acid. Oxaloacetic acid accepts acetyl group of the acetyl CoA and forms citric acid. Citric acid is the first stable compound formed in the Krebs' cycle hence the cycle is also known as citric acid cycle.

121. (a) :

Human urine	-	Auxin
Gibberella fujikuroi	-	Gibberellins
Herring sperm DNA	-	Cytokinin
Ripening fruit	-	Ethylene
Aged leaves of plant	-	Abscisic acid.

122. (c) : Denitrification is a chemical process in which nitrates in the soil are reduced to molecular nitrogen, which is released into the atmosphere. This process is effected by denitrifying bacteria *Pseudomonas denitrificans*

123. (a)

124. (c) : The Brunner's glands are found only in the duodenum and are located in the submucosa. They secrete a little enzyme and mucus. The mucus protects duodenal wall from getting digested. The Brunner's glands open into the crypts of Lieberkuhn.

125. (c) : Secretion of intestinal glands (which are crypts of Leiberkuhn and Brunner's gland) is called succus entericus or intestinal juice. Intestinal juice refers to the clear to pale yellow watery secretion from the glands lining the small intestine walls. Secretion is stimulated by the mechanical pressure of partly digested food in the intestine. Its function is to complete the process begun by pancreatic juice.

Intestinal juice contains hormones, digestive enzymes, mucus, substances to neutralize hydrochloric acid coming from the stomach.

126. (d)

127. (b) : The volume of air breathed in and out involuntarily in each normal breath is called tidal volume or TV. It is about 500 ml of air in average young adult man.

128. (a)

129. (b) : The shape of nucleus in different WBCs is as follows:
Eosinophils: bilobed.
Basophils: S-shaped.
Neutrophils: polymorphic.
Monocytes: kidney or bean-shaped.

130. (c) : Urine formation involves three main processes namely, glomerular filtration, reabsorption and secretion, that takes place in different parts of the nephron. A comparison of the volume of the filtrate formed per day (180 litres per day) with that of the urine released (1.5 litres), suggest that nearly 99 per cent of the filtrate is reabsorbed by the renal tubules. The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes. The ascending limb is impermeable to water but allows transport of electrolytes actively or passively. Conditional reabsorption of Na+ and water takes place in distal convoluted tubule. It is also capable of reabsorption of HCO_3^-.

131. (c)

132. (a) : The process of passing out of urine is called micturition. During the discharge of urine, the urethral sphincters relax and the smooth muscles of bladder wall gradually contracts.

133. (d) : Intervertebral or inter-articulated discs are present between the bodies of adjacent vertebrae from second cervical vertebra to the sacrum. Each disc has an outer fibrous ring consisting of fibrocartilage and an inner soft, pulpy, highly elastic substance. The discs form strong joints, permit various movements of the vertebral column and absorb vertical shock.

134. (c) **135. (c)** **136. (d)**

137. (a) : Addison's disease results from hyposecretion of adrenal cortex. Its symptoms include low blood sugar, low plasma Na^+, high plasma K^+, vomitting and bronze-like pigmentation of skin, etc.

138. (a) : Abnormal secretion of thyroxine constitutes both hyposecretion and hypersecretion of thyroxine. Hyposecretion of thyroxine causes cretinism and hypersecretion causes exophthalmic goitre.

139. (a) **140. (c)** **141. (c)** **142. (a)**

143. (d) : Ultrasonography is the only non-invasive method while the other three are invasive methods requiring penetration of the tissue by needle.

144. (c) : Diaphragms constitute the physical barriers of contraception, which prevent fertilization by blocking the entry of sperms through cervix. Diaphragm is a soft rubber cup that covers enterance to uterus. To increase its efficiency, spermicidal agents can be used alongwith it.

145. (b)

146. (b) : Apomixis is a reproductive process in plants. In apomixis there is no gametic fusion and embryo develops from a diploid cell of the ovule.

147. (b) : In the given figure A is coleoptile, B is coleorrhiza, C is radicle and D is scutellum.

148. (a) :

Gemmules	–	Sponges
Leaf buds	–	*Bryophyllum*
Bulbil	–	*Agave*
Offset	–	Water hyacinth
Conidia	–	*Penicillium*.

149. (c)

150. (c) : Binary fission is a means of reproduction in unicellular organisms where parent cell divides into two daughter unicells. In binary fission, the parent body as a whole constitutes the reproductive unit, and disappears when its division into daughter individuals is completed. However, the parent cannot be said to have died as no dead body is left. In fact, after binary fission, the parent continues living as two daughter individuals. Thus, the organisms that undergo binary fission are said to be immortal.

151. (d)

152. (c) : Colourblindness is a X-linked recessive trait. If woman is normal then all the sons will be normal because son always gets X chromosome from mother never from father. If man is colourblind and woman is normal, then all the girls will be carrier. None of them will be colourblind because girls get one X chromosome from father and other from mother, hence every girl has one normal X chromosome and one defective chromosome. So all children will be normal.
XY = Normal son
XX^c = Carrier but phenotypically normal daughter.

153. (d)

154. (d) : *ii* genotype does not produce any sugar polymer on the surface of the RBC. The I^A and I^B alleles produce enzyme called glycosyltransferase for the synthesis of sugars. The sugars are attached to lipids and produce glycolipids. These glycolipids then associate with membrane of RBC to form blood group antigens. Allele *i* does not produce any enzyme/ antigen.

155. (b) : In 1990, US Department of Energy and National Institute of Health embarked and coordinated on the project of sequencing human genome and called it Human Genome Project. The main aim of HGP is to determine the sequence and number of all the base pairs in the human genome.

156. (a) **157. (c)**

158. (d) : Variations among individuals are important in natural selection. Variations are the important factor in the theory of natural selection given by Darwin.

159. (a) : 'Smack' is a derivative of 'opium'. Opium is dried latex of unripe capsular fruits of poppy plant, *Papaver somniferum* (family - Papaveraceae). Smack is commonly called as 'Brown sugar'. It is a strong analgesic.

160. (b) : Plague is a bacterial disease, caused by *Yersinia pestis*.

161. (c) : A protooncogene is a gene whose protein product has the capacity to induce cellular transformation, given it sustains some genetic mutation. Tumour suppressor gene normally keeps mitosis in check and prevent cancer from occuring. This gene is inactivated or removed to eliminate control of cell cycle and initiate cancer.

162. (a) **163. (d)** **164. (d)** **165. (b)**
166. (c)

167. (a) : Genetically engineered insulin or humulin can be produced by inserting human insulin gene into plasmid isolated from *E. coli* bacterium and then production of a number of copies or clone of that recombinant gene into another *E. coli* bacterium.

168. (c) : Transgenic *Brassica napus* seeds are being used to produce the anticoagulant hirudin. Bt in "Bt cotton" stands for *Bacillus thuringiensis*. This is naturally occurring soil bacterium. Somatic hybridization involves fusion of protoplast of two cells. "Flavr savr" is genetically engineered tomatoes having increased shelf life and better nutrient quality.

169. (c)

170. (d) : Vector are gene carriers used in genetic engineering. A vector must be able to replicate (thus requires origin of replication), easily identifiable in order to select transformed cells (thus requires selectable marker) and easily cleavable into fragments to add foreign DNA (thus requires presence of sites for restriction endonucleases).

171. (c) : Mortality means death rate of population while natality is the death rate. Immigration is entry of individuals into the population while emigration means exit of individuals. Thus mortality and emigration will necessarily decrease the density of a population.

172. (d) **173. (a)** **174. (d)** **175. (c)**

176. (c) : Hot-spots are those regions of rich biodiversity which have been declared sensitive due to direct or indirect interference of human activities. Norman Myers was the first to develop hot spots concept in 1988 to designate priority areas for *in situ* conservation. The two main criteria for determining a hot spot are - number of endemic species, and degrees of threat in terms of habitat loss. Thirty four terrestrial hot spots have been identified throughout the world. Of these, three are located in India and neighbouring countries. These three hot spots are Western Ghats, Indo-Burma region and the Eastern Himalayas.

177. (c) : Excessive exploitation of a species, whether a plant or animal reduces size of its population so that it becomes vulnerable to extinction. Sea Cow have become extinct in the last 500 years due to over exploitation by humans.

178. (a)

179. (c) : High concentration of DDT disturbs calcium metabolism in birds, which causes thinning of egg shell and their premature breaking, eventually causing decline in birds population.

180. (d)

PRACTICE PAPER AIIMS

Exam on : 1st June

1. Which of the following represents nucleophilic aromatic substitution reaction?
   (a) Reaction of benzene with Cl_2 in sunlight.
   (b) Hydrolysis of benzyl bromide.
   (c) Reaction of NaOH with dinitrofluorobenzene.
   (d) Sulphonation of benzene.

2. If two different gases are in the molar ratio $n_1 : n_2$, then which of the following need not be in the ratio $n_1 : n_2$?
   (a) Their volume ratio at same P and T
   (b) Their ratio in terms of number of molecules
   (c) Their partial pressures in a mixture
   (d) Their densities at same P and T

3. Which of the following has maximum number of isotopes?
   (a) Ga (b) H
   (c) C (d) Sn

4. Chloropicrin is
   (a) $CCl_3(NO_2)_2$ (b) CCl_2HNO_2
   (c) $CClH_2NO_2$ (d) CCl_3NO_2

5. 0.1 M NaCl and 0.05 M $BaCl_2$ solutions are separated by a semipermeable membrane in a container. For this system, choose the correct answer.
   (a) There is no movement of any solution across the membrane.
   (b) Water flows from $BaCl_2$ solution towards NaCl solution.
   (c) Water flows from NaCl solution towards $BaCl_2$ solution.
   (d) Osmotic pressure of 0.1 M NaCl is lower than the osmotic pressure of 0.05 M $BaCl_2$ (Assume complete dissociation).

6. What is the volume of "20 volume H_2O_2" required to get 5000 cm^3 of oxygen at STP?
   (a) 250 cm^3 (b) 20 cm^3
   (c) 100 cm^3 (d) 125 cm^3

7. Which of the following compounds decolourises cold alkaline $KMnO_4$ but cannot give a red precipitate with ammoniacal Cu_2Cl_2?
   (a) $CH_3C \equiv CH$ (b) $CH_3CH = CH_2$
   (c)  (d) $CH_3CH_2CH_3$

8. Which of the following is isostructural to I_3^-?
   (a) ICl_2^-, XeF_2, N_3^- (b) NO_2^-, XeF_2, N_3^-
   (c) NH_2^-, NO_2^-, ICl_2^- (d) BH_3, CO_2, ICl_2^-

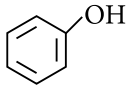
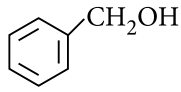
9. Cerium (Z = 58) is an important member of lanthanides. Which of the following statements about cerium is incorrect?
   (a) The common oxidation states of cerium are +3 and +4.
   (b) The +3 oxidation state of cerium is more stable than the +4 oxidation state.
   (c) The +4 oxidation state of cerium is not known in solutions.
   (d) Cerium (IV) acts as an oxidising agent.

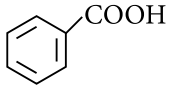
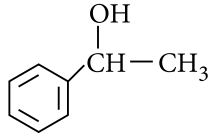
10. Heating a particular ether with HBr yielded a single organic product. Which of the following conclusions may be reached?
    (a) The reactant was ethyl methyl ether.
    (b) The reactant was a symmetric ether.
    (c) The reactant was a cyclic ether.
    (d) Both (b) and (c) may be correct.

11. The ratio of the difference in energy between the first and the second Bohr orbit to that between the second and the third Bohr orbit is
    (a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{4}{9}$ (d) $\frac{27}{5}$

12. Electron gain enthalpy is positive, when
    (a) O changes into O^-
    (b) O^- changes into O^{2-}
    (c) O changes into O^+
    (d) electron gain enthalpy is always negative.

13. Arrange the given compounds in order of increasing acidic character.

(I)  (II) 

(III)  (IV) 

(a) III > II > I > IV (b) III > IV > II > I
(c) III > I > II > IV (d) I > III > II > IV

14. Consider the following cell reaction :

$$Mg_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Cu_{(s)} + Mg^{2+}_{(aq)}$$

If the standard reduction potentials of Mg^{2+}/Mg and Cu^{2+}/Cu are – 2.37 V and + 0.34 V respectively, $E°$ for the cell is

(a) –2.71 V (b) +2.71 V
(c) –2.03 V (d) +2.03 V

15. The decomposition temperature is maximum for

(a) $MgCO_3$ (b) $CaCO_3$
(c) $BaCO_3$ (d) $SrCO_3$

16. Nucleophilic attack on carbonyl carbon changes its hybridisation from

(a) sp to sp^2 (b) sp^2 to sp^3
(c) sp^3 to sp^2 (d) sp to sp^3

17. For the reactions, $A \longrightarrow B$; $k_1 = 10^8\, e^{-\frac{6000}{8.34T}}$

and $P \longrightarrow Q$; $k_2 = 10^{10}\, e^{-\frac{8000}{8.34T}}$

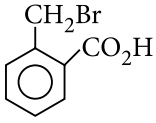
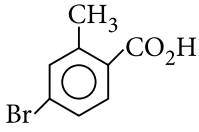
The temperature at which $k_1 = k_2$ is

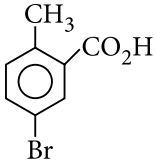
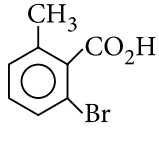
(a) 386 K (b) 221 K
(c) 26 K (d) 52 K

18. Boric acid is used in carrom board for smooth gliding of pawnpucks because

(a) its low density makes it fluffy
(b) it can be powdered to a very small grain size
(c) it is chemically inert with the plywood
(d) H-bonding in H_3BO_3 gives it a layered structure.

19. *o*-Toluic acid on reaction with Br_2 and Fe gives

(a)  (b) 

(c)  (d) 

20. If the equilibrium pressure for the reaction :

$$Co(H_2O)_4Cl_3{\cdot}2H_2O_{(s)} \rightleftharpoons [Co(H_2O)_4Cl_2]Cl_{(s)} + 2H_2O_{(g)}$$

at 500 K is $\frac{\pi}{2}$atm. So, the K_p for the given reaction is

(a) $\frac{\pi^2}{2}$ atm^2 (b) π^2atm^2
(c) $4\pi^2$atm^2 (d) $\frac{\pi^2}{4}$ atm^2

21. Identify *B* in the following reaction.

$$H_4SiO_4 \xrightarrow[-H_2O]{1000°C} A \xrightarrow[\Delta]{\text{Carbon}} B + CO$$

(a) Corundum (b) Quartz
(c) Silica (d) Carborundum

22. Which of the following chemicals are used to manufacture methyl isocyanate that caused "Bhopal Gas Tragedy"?

(i) Methylamine (ii) Phosgene
(iii) Phosphine (iv) Dimethylamine
(a) (i) and (iii) (b) (iii) and (iv)
(c) (i) and (ii) (d) (ii) and (iv)

23. In the following reaction :

$$M^{x+} + MnO_4^- \longrightarrow MO_3^- + Mn^{2+} + \frac{1}{2}O_2,$$

if one mole of MnO_4^- oxidises 2.5 moles of M^{x+}, then the value of x is

(a) 5 (b) 3
(c) 4 (d) 2

24. Which of the following oxyacids does not exist?

(a) H_3SbO_3 (b) $HBiO_3$
(c) H_3AsO_4 (d) H_3BiO_4

25. Among the following which one can have a meso form?

(a) $CH_3CH(OH)CH(Cl)C_2H_5$
(b) $CH_3CH(OH)CH(OH)CH_3$
(c) $C_2H_5CH(OH)CH(OH)CH_3$
(d) $HOCH_2CH(Cl)CH_3$

26. Which among the following statements are correct with respect to adsorption of gases on a solid?

(i) The extent of adsorption is equal to kp^n according to Freundlich isotherm.
(ii) The extent of adsorption is equal to $kp^{1/n}$ according to Freundlich isotherm.
(iii) The extent of adsorption is equal to $(1 + bp)/ap$ according to Langmuir isotherm.
(iv) The extent of adsorption is equal to $ap/(1 + bp)$ according to Langmuir isotherm.
(a) (i) and (iii) (b) (i) and (iv)
(c) (ii) and (iii) (d) (ii) and (iv)

27. Increase in volume of a gas from a given decrease of pressure is more in an isothermal process than in an adiabatic expansion because
(a) in isothermal and adiabatic expansion, the internal energy of systems remains same
(b) in isothermal expansion, temperature remains same whereas in adiabatic expansion, temperature decreases
(c) in isothermal expansion, $q = w$ while in adiabatic expansion, $\Delta U = w$
(d) in isothermal expansion, work is done by the system while in adiabatic, work is done on the system.

28. Which is not classified as thermoplastics?
(a) Polyethylene (b) Polystyrene
(c) Bakelite (d) Neoprene

29. Which is not the correct statement for ionic solids in which positive and negative ions are held by strong electrostatic attractive forces?
(a) The radius r_+/r_- increases as coordination number increases.
(b) As the difference in size of ions increases, coordination number increases.
(c) When coordination number is eight, the r_+/r_- ratio lies between 0.225 to 0.414.
(d) In ionic solid of the type *AX* (ZnS, Wurtzite), the coordination number of Zn^{2+} and S^{2-} respectively are 4 and 4.

30. Which of the following is not the correct process.
(a) Leaching : Ag
(b) Zone refining : Sn
(c) Liquation : Sn
(d) van Arkel : Zr

31. Which one of the following is a non-steroidal hormone?
(a) Estradiol (b) Prostaglandin
(c) Progesterone (d) Estrone

32. Equimolar solutions in the same solvent have
(a) different boiling and different freezing points
(b) same boiling and same freezing points
(c) same freezing point but different boiling point
(d) same boiling point but different freezing point.

33. XeF_6 on complete hydrolysis produces
(a) $XeOF_4$ (b) XeO_2F_2
(c) XeO_3 (d) XeO_2

34. Aromatic nitriles (ArCN) are not prepared by which of the following reaction?
(a) Ar*X* + KCN (b) $ArN_2^+Cl^-$ + CuCN
(c) $ArCONH_2 + P_2O_5$ (d) $ArCONH_2 + SOCl_2$

35. The equivalent weight of phosphoric acid (H_3PO_4) in the reaction :
$NaOH + H_3PO_4 \rightarrow NaH_2PO_4 + H_2O$ is
(a) 25 (b) 49
(c) 59 (d) 98

36. The stability of complexes of Cu^{2+}, Ni^{2+}, Co^{2+} and Fe^{2+} varies in the order
(a) $Cu^{2+} > Ni^{2+} > Co^{2+} > Fe^{2+}$
(b) $Cu^{2+} > Fe^{2+} > Ni^{2+} > Co^{2+}$
(c) $Ni^{2+} > Co^{2+} > Fe^{2+} > Cu^{2+}$
(d) $Cu^{2+} < Ni^{2+} < Co^{2+} < Fe^{2+}$

37. Lassaigne's test for the detection of nitrogen fails in
(a) $H_2N - CO - NHNH_2 \cdot HCl$
(b) $NH_2 - NH_2 \cdot HCl$
(c) $C_6H_5 - NH - NH_2 \cdot HCl$
(d) $C_6H_5CONH_2$

38. Which of the following statements is not correct?
(a) CO is the main air pollutant.
(b) All pollutants are not wastes.
(c) Water is polluted if B.O.D. is less.
(d) Lichens are pollution indicators.

39. Formation of coloured ions by transition metals signifies
(a) absorption of light from UV range
(b) emission of light
(c) presence of unpaired electrons in *s* and *p* orbitals
(d) complementary colours to the absorbed light.

40. If *xy* is molecular plane, then $d\pi$-$p\pi$ bonding that is possible in SO_2 molecule can be represented as
(a) $3d_{z^2} - 2p_z$ (b) $3d_{xy} - 2p_z$
(c) $3d_{z^2} - 2p_x$ (d) $3d_{xz} - 2p_z$

ASSERTION AND REASON

Directions : In the following questions (41-60), a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

41. **Assertion :** Lowering in vapour pressure is directly proportional to the osmotic pressure of the solution.
Reason : Osmotic pressure is a colligative property.

42. **Assertion :** In van der Waals' equation

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

pressure correction, $\left(\frac{a}{V^2}\right)$, is due to force of attraction between molecules.
Reason : Due to force of attraction, volume of molecules cannot be neglected.

43. **Assertion :** In SO_2, the bond angle is 119° whereas in SO_3, the bond angle is 120°.
Reason : S atom in both SO_2 and SO_3 is sp^2- hybridized.

44. **Assertion :** In electrolysis, the quantity of electricity needed for depositing 1 mole of silver is different from that required for 1 mole of copper.
Reason : The molecular weights of silver and copper are different.

45. **Assertion :** Na^+ and Al^{3+} are isoelectronic but the magnitude of ionic radius of Al^{3+} is less than that of Na^+.
Reason : The magnitude of effective nuclear charge of the outershell electrons in Al^{3+} is greater than that in Na^+.

46. **Assertion :** The molecularity of the reaction, $H_2 + Br_2 \longrightarrow 2HBr$ is two.
Reason : The order of this reaction is 3/2.

47. **Assertion :** When KI solution is added to $AgNO_3$ solution, negatively charged sol results.
Reason : When KI solution is added to $AgNO_3$ solution, negative charge of sol is due to preferential adsorption of iodide ions from the dispersion medium.

48. **Assertion :** White P reacts with caustic soda, the products are PH_3 and NaH_2PO_2. This reaction is an example of disproportionation reaction.
Reason : In disproportionation reaction, same substance may act simultaneously as an oxidising agent and as a reducing agent.

49. **Assertion :** For an isothermal reversible process $q = -w$ *i.e.* work done by the system equals the heat absorbed by the system.
Reason : Enthalpy change (ΔH) is zero for isothermal process.

50. **Assertion :** S_N1 mechanism is facilitated by polar protic solvents like water, alcohol etc.
Reason : $C_6H_5CH(C_6H_5)Br$ is less reactive than $C_6H_5CH(CH_3)Br$ in S_N1 reactions.

51. **Assertion :** H_2O_2 has higher boiling point than water.
Reason : H_2O_2 has stronger dipole-dipole interactions than that shown by water.

52. **Assertion :** $BeSO_4$ is soluble in water while $BaSO_4$ is not.
Reason : Lattice energy of $BaSO_4$ exceeds its hydration energy.

53. **Assertion :** Aqueous solution of phenol is called as carbonic acid.
Reason : Increasing order of acidity of phenols is *m*-nitrophenol > *o*-nitrophenol > *p*-nitrophenol.

54. **Assertion :** White phosphorus is more reactive than red phosphorus.
Reason : White phosphorus readily catches fire in air to give dense white fumes of P_4O_{10}.

55. **Assertion :** NF_3 is a weaker ligand than $N(CH_3)_3$.
Reason : NF_3 ionizes to give F^- ions in aqueous solution.

56. **Assertion :** Direct attachment of groups such as phenyl or vinyl to the carboxylic acid, increases the acidity of the carboxylic acid.
Reason : Resonance effect always increases the acidity of carboxylic acids.

57. **Assertion :** The solubility of AgCl in water decreases if NaCl is added to it.
Reason : NaCl is highly soluble in water whereas AgCl is sparingly soluble.

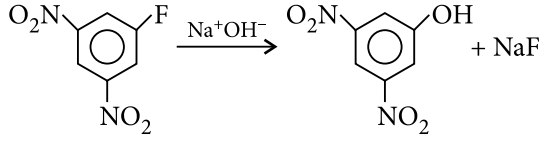
58. **Assertion :** β-hydrogen atom of carbonyl compounds is acidic in nature.
Reason : β-hydrogen is directly attached to carbon next to carbonyl carbon.

59. **Assertion :** On heating a solid for a longer time, radiations become white and then blue as the temperature becomes very high.
Reason : Radiations emitted go from a lower frequency to higher frequency as the temperature increases.

60. **Assertion :** Frenkel defect is also called dislocation defect.
Reason : Frenkel defect is shown by ionic substances in which cation and anion are of almost similar sizes.

SOLUTIONS

1. **(c) :** Reaction of NaOH with dinitrofluorobenzene represents nucleophilic aromatic substitution reaction because —NO_2 group is deactivating group. They make benzene nucleus electron deficient and facilitate the nucleophile to attack the ring.



2. (d): If two gases are different, their molecular masses may also be different. So, densities need not be in the ratio $n_1 : n_2$.

3. (d): Tin has ten isotopes.

4. (d): $\underset{\text{Chloroform}}{CHCl_3} + \underset{\text{Nitric acid}}{HONO_2} \longrightarrow \underset{\text{Chloropicrin}}{CCl_3NO_2} + H_2O$

5. (b): The concentration of $BaCl_2$ solution (0.05 M) is lower, thus solvent (water) moves from the $BaCl_2$ solution towards NaCl solution (0.1 M).

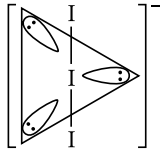
6. (a): "20 volume H_2O_2" means 1 mL of H_2O_2 gives 20 mL oxygen on decomposition at STP.

Hence, 5000 cm^3 O_2 will be obtained by $\frac{5000}{20}$

$= 250\ cm^3$ of H_2O_2

7. (b): (a) and (b) both are unsaturated hydrocarbons and can decolourise cold alkaline $KMnO_4$ but only (a) being terminal alkyne, can give a precipitate with Cu_2Cl_2. (c) and (d) are saturated and cannot decolourise $KMnO_4$.

8. (a): I_3^- ion is linear.



ICl_2^-, XeF_2 and N_3^- ions are also linear.

9. (c)

10. (d): Both symmetric ether and cyclic ether give the single product on reaction with HBr.

11. (d): $E_2 - E_1 = 1312 \times Z^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

$E_2 - E_1 = 1312 \times Z^2\left[\frac{3}{4}\right]$ ...(i)

$E_3 - E_2 = 1312 \times Z^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

$E_3 - E_2 = 1312 \times Z^2\left[\frac{5}{36}\right]$ ...(ii)

On dividing eqns. (i) and (ii), we get

$$\frac{E_2 - E_1}{E_3 - E_2} = \frac{3 \times 36}{4 \times 5} = \frac{27}{5}$$

12. (b): Due to repulsions between the electrons on O^- and the additional incoming electron, the electron gain enthalpy of O^- is positive.

13. (c): The order of acidic character is

carboxylic acid > phenol > alcohols.

The acidic character of alcohols follows the order :

$1° > 2° > 3°$

as an electron releasing group ($-R$) increases the electron density on oxygen, tending to decrease the polarity of O — H bond hence, decreases the acidic strength.

14. (b): The cell is represented as

$Mg_{(s)}|Mg^{2+}_{(aq)}||Cu^{2+}_{(aq)}|Cu_{(s)}$

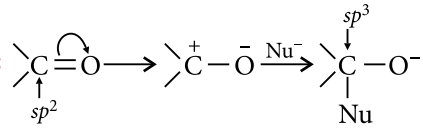
$E^\circ = E^\circ_{Cu^{2+}|Cu} - E^\circ_{Mg^{2+}|Mg}$

$= 0.34 - (-2.37) = 2.71$ V

15. (c): Greater the electropositive character, more will be the stability and high will be the decomposition temperature. $BeCO_3$ decomposes at 373 K, $MgCO_3$ at 813 K, $CaCO_3$ at 1173 K, $SrCO_3$ at 1563 K and $BaCO_3$ at 1633 K *i.e.*, the thermal stability increases in the order :

$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

16. (b):



17. (d): $k_1 = k_2$

$10^8\ e^{-\frac{6000}{8.34T}} = 10^{10}\ e^{-\frac{8000}{8.34T}}$

$\frac{10^{10}}{10^8} = e^{\frac{2000}{8.34T}}$

$\Rightarrow \quad 2.303 \log 100 = \frac{2000}{8.34\ T}$

$\Rightarrow \quad T = \frac{2000}{2.303 \times 2 \times 8.34} = 52$ K

18. (d): Slippery nature of boric acid is due to the presence of hydrogen bonding.

19. (c): $-CH_3$ group is *o*- and *p*-directing group, however $-COOH$ group is *m*-directing, thus the new entering electrophile (Br^+) occupies the position which is meta *w.r.t.* $-COOH$ group and para *w.r.t.* $-CH_3$ group.

20. (d): If the total pressure is $\frac{\pi}{2}$ atm, then

$p_{H_2O} = \frac{\pi}{2}$ atm

$K_p = (p_{H_2O})^2 = \left(\frac{\pi}{2}\right)^2 = \frac{\pi^2}{4}$ atm^2

21. (d): Orthosilicic acid (H_4SiO_4), on heating at high temperature, loses two water molecules and gives silica (SiO_2) which on reduction with carbon gives carborundum (SiC) and CO.

$$\underset{}{H_4SiO_4} \xrightarrow[-2H_2O]{1000°C} \underset{\text{Silican}}{\underset{(A)}{SiO_2}} \xrightarrow[\Delta]{\text{Carbon}} \underset{\text{Carborundum}}{\underset{(B)}{SiC}} + CO$$

22. (c) : Methyl isocyanate is industrially prepared by the reaction of methylamine with phosgene.

$$CH_3NH_2 + COCl_2 \xrightarrow{-HCl} [CH_3NH - CO - Cl]$$

$$\xrightarrow[-HCl]{\Delta} CH_3 - N = C = O$$

Methyl isocyanate

23. (b):

Oxidation (Change in oxidation state = 2)

$$M^{x+} + \overset{+7}{MnO_4^-} \longrightarrow \overset{+5}{MO_3^-} + Mn^{2+} + \frac{1}{2}O_2$$

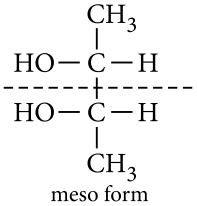
Change in oxidation state = 5 (Reduction)

$$x + 2 = 5$$

$$x = 5 - 2 = +3$$

24. (d): Arsenic forms two oxyacids H_3AsO_3 and H_3AsO_4. Antimony forms only one oxyacid H_3SbO_3 and bismuth forms only one oxyacid $HBiO_3$. Therefore H_3BiO_4 does not exist.

25. (b):



meso form

26. (d): Extent of adsorption, $\frac{x}{m} = kp^{1/n}$

(Freundlich adsorption isotherm)

The amount of gas adsorbed does not increase as rapidly as the pressure.

Extent of adsorption, $\frac{x}{m} = \frac{ap}{(1+bp)}$

(Langmuir adsorption isotherm)

where k, a, b are constants and p is a pressure.

27. (b): In isothermal expansion temperature remains same whereas in adiabatic expansion temperature decreases since the final pressure is the same so it follows Charles' law, $V \propto T$ at constant P

$V_{iso} > V_{adi}$

$\Delta V_{iso} = V_{iso} - V_{initial}$

$\Delta V_{adi} = V_{adi} - V_{initial}$

So, $\Delta V_{iso} > \Delta V_{adi}$

28. (c)

29. (c) : When coordination number is eight, the radius ratio r_+/r_- lies between 0.732 to 1.000.

30. (b)

31. (b): Prostaglandin is not a steroidal hormone. It is a derivative of fatty acid.

32. (b): Boiling point and freezing point depend on K_b (molal elevation constant) and K_f (molal depression constant) of the solvent. Thus, equimolar solutions in the same solvent will have same boiling point and also same freezing point.

$\Delta T_f = K_f \times m$

$\Delta T_b = K_b \times m$

33. (c) : $XeF_{6(s)} + 3H_2O_{(l)} \longrightarrow \underset{\text{highly explosive}}{XeO_{3(s)}} + 6HF_{(aq)}$

34. (a) : ArX + KCN ⟶ No reaction while others will form ArCN.

35. (d): $NaOH + H_3PO_4 \rightarrow NaH_2PO_4 + H_2O$

Molecular mass of H_3PO_4 is 98. As there is only one electron change involved therefore, equivalent weight of H_3PO_4 in this reaction is 98.

36. (d): When cations have same charge but different number of d-electrons then the stability decreases with increase in the number of d-electrons. Therefore, the correct order is

$$Fe^{2+} > Co^{2+} > Ni^{2+} > Cu^{2+}$$

37. (b): Lassaigne's test is given by those nitrogenous compounds in which carbon is also present along with nitrogen.

In $NH_2—NH_2 \cdot HCl$, carbon is absent, so it does not give Lassaigne's test.

38. (c) : Highly polluted water has BOD value of more than 17 ppm.

39. (d): Transition metals due to the presence of partially filled d-orbitals, are coloured.

The unpaired electron present in partially filled d-orbital is excited to the higher energy d-orbital by absorbing energy from visible light and thus, exhibits the complementary colour. Due to which the transition metal ions appear coloured.

40. (d): In SO_2, σ-bond is formed in xy plane so, one π-bond is formed by overlap of $3p_z$ orbital of S and $2p_z$ orbital of O atom while the second π-bond is formed between $3d_{xz}$ orbital of S and $2p_z$ orbital of O because $3d_{xz}$ orbital is in correct orientation for π-overlap with $2p_z$ ortbital on the oxygen atom.

41. (b): The relationship between lowering in vapour pressure and osmotic pressure can be derived as follows :

van't Hoff equation for a dilute solution is

$$\pi = \frac{n}{V}RT \qquad \ldots(i)$$

In case of a dilute solution, the volume of solution can be taken as equal to that of solvent. If N is the number of moles of solvent having molecular weight M and density ρ, then the volume V is given by

$$V = \frac{NM}{\rho} \qquad \ldots(ii)$$

or $$\frac{n}{N} = \frac{\pi M}{\rho RT} \qquad \ldots(iii)$$

From Raoult's law,

$$\frac{p^\circ - p}{p^\circ} = \frac{n}{N} \qquad \ldots(iv)$$

$$\therefore \quad \frac{p^\circ - p}{p^\circ} = \frac{\pi M}{\rho RT} \qquad \text{(From eqns. (iii) and (iv))}$$

$$\text{or} \quad (p^\circ - p) = \frac{\pi M}{\rho RT} \times p^\circ$$

The factor $\frac{Mp^\circ}{\rho RT}$ is constant at constant temperature.

$\therefore \quad (p^\circ - p) \propto \pi$

or lowering in vapour pressure $\propto$ osmotic pressure. Also osmotic pressure is a colligative property.

42. (c) : At high pressure and low temperature, overall volume (V) of gas may be so small that the volume occupied by gas molecules (b) cannot be neglected.

43. (b) : S atom in both SO_2 and SO_3 is sp^2-hybridized but due to *lp-bp* repulsion in SO_2, bond angle in SO_2 is less than that in SO_3.

44. (b) : $Ag^+ + e^- \rightarrow Ag$, $Cu^{2+} + 2e^- \rightarrow Cu$

For deposition of Ag, 1 mole of electrons is required while for deposition of Cu, 2 moles of electrons are required. So, quantity of electricity needed for depositing is different.

45. (a)

46. (b) : $H_2 + Br_2 \longrightarrow 2HBr$; rate = $k[H_2][Br_2]^{1/2}$

Molecularity of this reaction is 2.

Order = $1 + \frac{1}{2} = \frac{3}{2}$

47. (d) : When KI solution is added to $AgNO_3$ solution, positively charged sol results due to adsorption of Ag^+ ions from dispersion medium.

When $AgNO_3$ solution is added to KI solution, the precipitated silver iodide adsorbs iodide ions from the dispersion medium and negatively charged sol results.

48. (a) : $P_4 + 3NaOH + 3H_2O \xrightarrow[CO_2]{\Delta} \underset{\text{Phosphine}}{PH_3} + \underset{\text{Sodium hypophosphite}}{3NaH_2PO_2}$

Here, P changes its oxidation state from 0 to –3 ($P \rightarrow PH_3$) and also from 0 to +1 ($P \rightarrow NaH_2PO_2$).

49. (b) : In an isothermal process, change in internal energy (ΔE) is zero (as it is a function of temperature).

According to first law of thermodynamics,

$\because \quad q + w = \Delta E$ hence $q = -w$ (if $\Delta E = 0$)

This means work done by the system equals the heat absorbed by the system.

50. (c) : Carbocation intermediate obtained from $C_6H_5CH(C_6H_5)Br$ is more stable than that obtained from $C_6H_5CH(CH_3)Br$ because it is stabilized by two phenyl groups due to resonance. Therefore, the former bromide is more reactive than the latter in S_N1 reactions.

51. (c) : H_2O_2 is more extensively associated by hydrogen bonding than water.

52. (a) : As we move down the group from Be to Ba, lattice energy remains constant and the hydration energy decreases from Be^{2+} to Ba^{2+}. Thus, the solubility of sulphates decreases down the group as lattice energy exceeds hydration energy in case of $BaSO_4$.

53. (d) : Aqueous solution of phenol is called carbolic acid. Electron withdrawing groups such as $-NO_2$, $-CN$, $-X$ increase the acidity. The increase is more at *o*- and *p*- positions than at *m*-position. Thus, the increasing order of acidity of phenols is

p-nitrophenol > *o*-nitrophenol > *m*-nitrophenol.

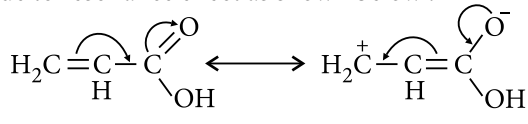
54. (b) : White phosphorus is less stable and more reactive than red phosphorus because of angular strain in the P_4 molecule where the angles are only 60°. Therefore, it readily catches fire in air, produces dense white fumes of phosphorus pentoxide.

$P_{4(s)} + 5O_{2(g)} \longrightarrow P_4O_{10(s)}$

55. (c) : Due to high electronegativity of F-atoms, the lone pair of N-atom in NF_3 molecule cannot be ligated easily. Whereas in $N(CH_3)_3$, $-CH_3$ group is an electron releasing group, thus lone pair of N-atom in $N(CH_3)_3$ molecule can be ligated easily. Except, nitrogen fluoride, all other halides hydrolyse in water.

$$NCl_3 + 3H_2O \rightarrow NH_3 + 3HOCl$$

56. (c) : This is due to greater electronegativity of sp^2 hybridised carbon to which carboxyl carbon is attached which is contrary to the decrease expected due to resonance effect as shown below :



57. (b) : In presence of NaCl, $[Cl^-]$ increases very much. Hence, $[Ag^+]$ decreases to keep K_{sp} constant.

58. (d) : α - hydrogen which is attached to carbon next to carbonyl carbon is acidic in nature.

59. (a)

60. (c) : Frenkel defect is called dislocation defect because smaller ion (generally the cation) is dislocated from its normal site to an interstitial site. It is shown by ionic substances in which there is large difference in the size of ions *e.g.* ZnS, AgCl.

CBSE BOARD SOLVED PAPER 2015

CLASS XII

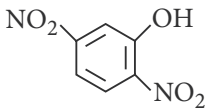
Time allowed : 3 hours | Maximum Marks : 70

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) Q. no. 1 to 5 are very short answer questions and carry 1 mark each.
(iii) Q. no. 6 to 10 are short answer questions and carry 2 marks each.
(iv) Q. no. 11 to 22 are also short answer questions and carry 3 marks each.
(v) Q. no. 23 is a value based question and carry 4 marks.
(vi) Q. no. 24 to 26 are long answer questions and carry 5 marks each.
(vii) Use log tables if necessary, use of calculators is not allowed.

1. What is the basicity of H_3PO_4?

2. Write the IUPAC name of the given compound:



3. Which would undergo S_N2 reaction faster in the following pair and why?

$$CH_3-CH_2-Br \text{ and } CH_3-\underset{\displaystyle Br}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_3$$

4. Out of $BaCl_2$ and KCl, which one is more effective in causing coagulation of a negatively charged colloidal sol? Give reason.

5. What is the formula of a compound in which the element *Y* forms *ccp* lattice and atoms of *X* occupy $1/3^{rd}$ of tetrahedral voids?

6. What are the transition elements? Write two characteristics of the transition elements.

7. **(i)** Write down the IUPAC name of the following complex:
$[Cr(NH_3)_2Cl_2(en)]Cl$ (*en* = ethylenediamine)
(ii) Write the formula for the following complex:
Pentaamminenitrito-O-cobalt (III).

8. Name the reagents used in the following reactions:
(i) $CH_3-CO-CH_3 \xrightarrow{?} CH_3-\underset{\displaystyle OH}{\overset{\displaystyle }{\overset{|}{\underset{|}{CH}}}}-CH_3$

(ii) $C_6H_5-CH_2-CH_3 \xrightarrow{?} C_6H_5-COO^-K^+$

9. What is meant by positive deviations from Raoult's law? Give an example. What is the sign of $\Delta_{mix}H$ for positive deviation?

OR

Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law? Give an example.

10. **(a)** Following reactions occur at cathode during the electrolysis of aqueous silver chloride solution:

$$Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}, \quad E^\circ = +0.80 \text{ V}$$

$$H^+_{(aq)} + e^- \longrightarrow \frac{1}{2}H_{2(g)}, \quad E^\circ = 0.00 \text{ V}$$

On the basis of their standard reduction electrode potential (E°) values, which reaction is feasible at the cathode and why?

(b) Define limiting molar conductivity. Why conductivity of an electrolyte solution decreases with the decrease in concentration?

11. 3.9 g of benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the van't Hoff factor and predict the nature of solute (associated or dissociated).
(Given : Molar mass of benzoic acid = 122 g mol^{-1}, K_f for benzene = 4.9 K kg mol^{-1})

12. **(i)** Indicate the principle behind the method used for the refining of zinc.

(ii) What is the role of silica in the extraction of copper?

(iii) Which form of the iron is the purest form of commercial iron?

13. An element with molar mass 27 g mol^{-1} forms a cubic unit cell with edge length 4.05×10^{-8} cm. If its density is 2.7 g cm^{-3}, what is the nature of the cubic unit cell?

14. **(a)** How would you account for the following:

(i) Actinoid contraction is greater than lanthanoid contraction.

(ii) Transition metals form coloured compounds.

(b) Complete the following equation:

$2MnO_4^- + 6H^+ + 5NO_2^- \longrightarrow$

15. **(i)** Draw the geometrical isomers of complex $[Pt(NH_3)_2Cl_2]$.

(ii) On the basis of crystal field theory, write the electronic configuration of d^4 ion if $\Delta_o < P$.

(iii) Write the hybridization and magnetic behaviour of the complex $[Ni(CO)_4]$.
(At. no. of Ni =28)

16. Calculate emf of the following cell at 25°C:

$Fe|Fe^{2+}(0.001\ M)||H^+(0.01\ M)|H_{2(g)}(1\ bar)|Pt_{(s)}$

$E°(Fe^{2+}|Fe) = -0.44$ V, $E°(H^+|H_2) = 0.00$ V

17. Give reasons for the following observations:

(i) Leather gets hardened after tanning.

(ii) Lyophilic sol is more stable than lyophobic sol.

(iii) It is necessary to remove CO when ammonia is prepared by Haber's process.

18. Write the names and structures of the monomers of the following polymers:

(i) Nylon 6, 6 **(ii)** PHBV **(iii)** Neoprene

19. Predict the products of the following reactions:

(i) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}=O \xrightarrow[\text{(ii) KOH/Glycol, } \Delta]{\text{(i) } H_2N-NH_2} ?$

(ii) $C_6H_5-CO-CH_3 \xrightarrow{NaOH/I_2} ? + ?$

(iii) $CH_3COONa \xrightarrow[\Delta]{NaOH/CaO} ?$

20. How do you convert the following:

(i) Phenol to anisole

(ii) Propan-2-ol to 2-methylpropan-2-ol

(iii) Aniline to phenol

OR

(a) Write the mechanism of the following reaction:

$2CH_3CH_2OH \xrightarrow{H^+} CH_3CH_2-O-CH_2CH_3$

(b) Write the equation involved in the acetylation of Salicylic acid.

21. **(i)** Which one of the following is a disaccharide : Starch, Maltose, Fructose, Glucose?

(ii) What is the difference between fibrous protein and globular protein?

(iii) Write the name of vitamin whose deficiency causes bone deformities in children.

22. Give reasons:

(a) *n*-Butyl bromide has higher boiling point than *t*-butyl bromide.

(b) Racemic mixture is optically inactive.

(c) The presence of nitro group ($-NO_2$) at *o*/*p* positions increases the reactivity of haloarenes towards nucleophilic substitution reactions.

23. Mr. Roy, the principal of one reputed school organized a seminar in which he invited parents and principals to discuss the serious issue of diabetes and depression in students. They all resolved this issue by strictly banning the junk food in schools and to introduce healthy snacks and drinks like soup, lassi, milk etc. in school canteens. They also decided to make compulsory half an hour physical activities for the students in the morning assembly daily. After six months, Mr. Roy conducted the health survey in most of the schools and discovered a tremendous improvement in the health of students.

After reading the above passage, answer the following:

(i) What are the values (at least two) displayed by Mr. Roy?

(ii) As a student, how can you spread awareness about this issue?

(iii) What are tranquilizers? Give an example.

(iv) Why is use of aspartame limited to cold foods and drinks?

24. **(a)** Account for the following:

(i) Acidic character increases from HF to HI.

(ii) There is large difference between the melting and boiling points of oxygen and sulphur.

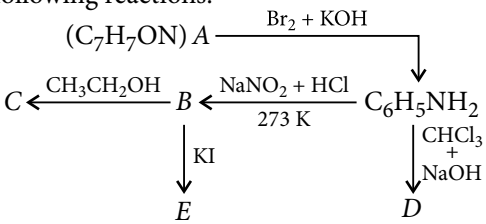
(iii) Nitrogen does not form pentahalide.

(b) Draw the structures of the following:
(i) ClF_3 (ii) XeF_4

OR

(i) Which allotrope of phosphorus is more reactive and why?
(ii) How the supersonic jet aeroplanes are responsible for the depletion of ozone layers?
(iii) F_2 has lower bond dissociation enthalpy than Cl_2. Why?
(iv) Which noble gas is used in filling balloons for meteorological observations?
(v) Complete the equation:
$XeF_2 + PF_5 \longrightarrow$

25. An aromatic compound '*A*' of molecular formula C_7H_7ON undergoes a series of reactions as shown below. Write the structures of *A*, *B*, *C*, *D* and *E* in the following reactions:



OR

(a) Write the structures of main products when aniline reacts with the following reagents:
(i) Br_2 water
(ii) HCl
(iii) $(CH_3CO)_2O$/pyridine

(b) Arrange the following in the increasing order of their boiling point:
$C_2H_5NH_2$, C_2H_5OH, $(CH_3)_3N$

(c) Give a simple chemical test to distinguish between the following pair of compounds:
$(CH_3)_2NH$ and $(CH_3)_3N$

26. For the hydrolysis of methyl acetate in aqueous solution, the following results were obtained:

t/s	0	30	60
$[CH_3COOCH_3]$/mol L^{-1}	0.60	0.30	0.15

(i) Show that it follows pseudo first order reaction, as the concentration of water remains constant.

(ii) Calculate the average rate of reaction between the time interval 30 to 60 seconds.
(Give log 2 = 0.3010, log 4 = 0.6021)

OR

(a) For a reaction $A + B \longrightarrow P$, the rate is given by Rate = $k[A][B]^2$
(i) How is the rate of reaction affected if the concentration of *B* is doubled?
(ii) What is the overall order of reaction if *A* is present in large excess?

(b) A first order reaction takes 30 minutes for 50% completion. Calculate the time required for 90% completion of this reaction. (log 2 = 0.3010)

SOLUTIONS

1. Basicity of H_3PO_4 is three as it has three ionisable hydrogen atoms.

2. 2, 5-Dinitrophenol.

3. $CH_3—CH_2—Br$ would undergo S_N2 reaction faster due to less steric hindrance.

4. $BaCl_2$ is more effective in causing coagulation of negatively charged colloidal sol because greater the valency of the coagulating ion, greater is its power to bring about coagulation.

5. No. of *Y* atoms per unit cell = $\frac{1}{8}\times 8+\frac{1}{2}\times 6 = 4$

No. of tetrahedral voids = $2 \times 4 = 8$

$\therefore$ No. of *X* atoms = $\frac{1}{3}\times 8=\frac{8}{3}$

Formula of compound = $X_{\frac{8}{3}}Y_4 = X_2Y_3$

6. Elements which have incompletely filled *d*-orbitals in their ground state or in any one of their oxidation states are called transition elements.
Characteristics of transition elements:
(i) They show variable oxidation states.
(ii) They exhibit catalytic properties.

7. **(i)** Diamminedichlorido(ethane-1, 2-diamine) chromium(III) chloride.
(ii) $[Co(NH_3)_5(ONO)]^{2+}$

8. **(i)** Lithium aluminium hydride ($LiAlH_4$)
(ii) Alkaline potassium permanganate ($KMnO_4$, KOH)

9. **Positive deviations from Raoult's law :** When observed vapour pressure of a liquid mixture is higher than the value expected from Raoult's law, it is called positive deviation from Raoult's law.

$P_T > x_A \cdot p^\circ_A + x_B \cdot p^\circ_B$

e.g.; Ethanol + Water
For positive deviations from Raoult's law,
$\Delta_{mix}H$ = +ve, ΔV_{mix} = +ve

OR

Liquid mixture which boils at constant temperature and remains unchanged in composition are called azeotropes.

The mixture which shows positive deviations from Raoult's law forms minimum boiling azeotropes.

Example: A mixture of ethanol and water containing 95.4% of ethanol forms minimum boiling azeotrope.

10. (a) The species that get reduced at cathode is the one having higher value of standard reduction potential. Hence, the reaction that will occur at cathode is $Ag^{+}_{(aq)} + e^{-} \longrightarrow Ag_{(s)}$.

(b) When concentration approaches zero, the molar conductivity is known as limiting molar conductivity.

Refer answer 7, Page 115

(MTG Excel in Chemistry)

11. $W_2 = 3.9$ g, $W_1 = 49$ g, $\Delta T_f = 1.62$ K, $M_2 = 122$ g mol^{-1}, $K_f = 4.9$ K kg mol^{-1},

$$\Delta T_f = i\, K_f m = i \times K_f \times \frac{W_2 \times 1000}{M_2 \times W_1}$$

$$\Rightarrow \quad 1.62 = \frac{i \times 4.9 \times 3.9 \times 1000}{122 \times 49}$$

$$\Rightarrow \quad i = \frac{1.62 \times 122 \times 49}{4.9 \times 3.9 \times 1000} = 0.506$$

As $i < 1$, solute is associated.

12. (i) Zinc is refined by electrolytic refining.

In this method, the impure metal is made to act as anode. A strip of the same metal in pure form is used as cathode. They are put in a suitable electrolytic bath containing soluble salt of the same metal. The more basic metal remains in the solution and the less basic ones go to the anode mud.

At anode: $Zn \longrightarrow Zn^{2+} + 2e^{-}$

At cathode: $Zn^{2+} + 2e^{-} \longrightarrow Zn$

(ii) Refer answer 9, Page 225

(MTG Excel in Chemistry)

(iii) Wrought iron is the purest form of commercial iron.

13. $M = 27$ g mol^{-1}, $a = 4.05 \times 10^{-8}$ cm, $d = 2.7$ g cm^{-3}

$$d = \frac{Z \times M}{N_A \times a^3} \quad \therefore \quad Z = \frac{d \times N_A \times a^3}{M}$$

$$Z = \frac{2.7 \times 6.022 \times 10^{23} \times (4.05 \times 10^{-8})^3}{27} = 4$$

As $Z = 4$, hence cubic unit cell is face centred cubic unit cell.

14. (a) (i) Refer answer 52(iii), Page 335

(MTG Excel in Chemistry)

(ii) Refer answer 11(c), Page 316

(MTG Excel in Chemistry)

(b) $2MnO_4^{-} + 6H^{+} + 5NO_2^{-} \longrightarrow 2Mn^{2+} + 5NO_3^{-} + 3H_2O$

15. (i) Refer answer 28, Page 371

(MTG Excel in Chemistry)

(ii) $t_{2g}^3\, e_g^1$

(iii) Refer answer 24(a), Page 371

(MTG Excel in Chemistry)

16. The cell reaction is

$$Fe_{(s)} + 2H^{+}_{(aq)} \longrightarrow Fe^{2+}_{(aq)} + H_{2(g)}$$

$E^{\circ}_{cell} = 0.00 - (-0.44) = 0.44$ V

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n} \log \frac{[Fe^{2+}]}{[H^{+}]^2}$$

$$= 0.44 - \frac{0.0591}{2} \log \frac{0.001}{(0.01)^2}$$

$= 0.44 - 0.02955 = 0.41045$ V

17. (i) Animal hides are colloidal in nature. When a hide, which has positively charged particles, is soaked in tannin, which contains negatively charged colloidal particles, mutual coagulation takes place. This results in the hardening of leather.

(ii) Lyophilic sol is more stable than lyophobic sol because it is highly hydrated in the solution.

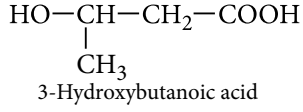
(iii) Refer answer 4, Page 196

(MTG Excel in Chemistry)

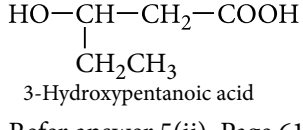
18. (i) Refer answer 5(i), Page 619

(MTG Excel in Chemistry)

(ii)



3-Hydroxybutanoic acid

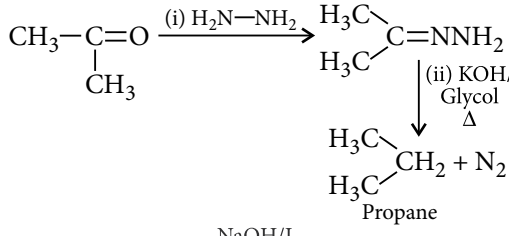


3-Hydroxypentanoic acid

(iii) Refer answer 5(ii), Page 619

(MTG Excel in Chemistry)

19. (i)



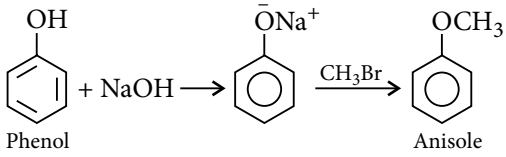
Propane

(ii)

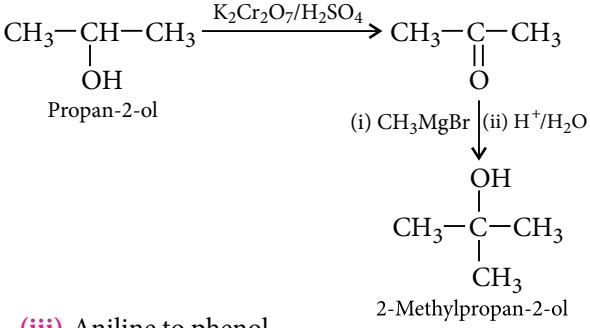
Iodoform

(iii) $CH_3COONa \xrightarrow[\Delta]{NaOH/CaO} CH_4 + Na_2CO_3$
Methane

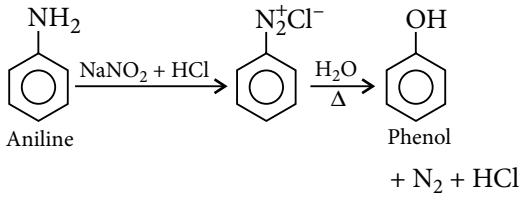
20. (i) Phenol to anisole



(ii) Propan-2-ol to 2-methylpropane-2-ol

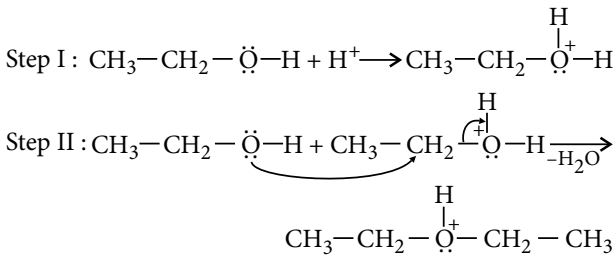


(iii) Aniline to phenol

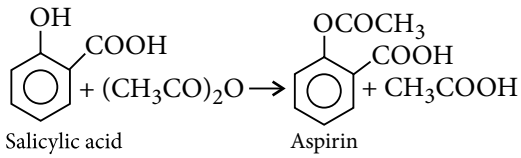


OR

(a) Mechanism : The formation of ether is nucleophilic bimolecular reaction.



(b)



21. (i) Maltose is disaccharide as it consists of two α-*D*-glucose units.

(ii) Refer answer 15, Page 579
(MTG Excel in Chemistry)

(iii) Vitamin D deficiency causes bone deformities in children.

22. (a) *n*-Butyl bromide, being a straight chain molecule have strong intermolecular forces whereas *t*-butyl bromide being a branched chain molecule have weaker intermolecular forces due to smaller surface area. Hence, boiling point of *n*-butyl bromide is higher than that of *t*-butyl bromide.

(b) Racemic mixture contains equal amount of *d* and *l* forms, hence rotation due to one enantiomer is cancelled by another.

(c) The presence of nitro group at *o*- and *p*-positions withdraws electrons from the benzene ring and thus, facilitates the attack of the nucleophile on haloarenes. The carbanion thus formed is further stabilised by resonance.

23. (i) Mr. Roy displayed responsibility and concern towards the health needs of students.

(ii) Awareness regarding diabetes and depression can be spread by conducting workshops for students, teachers as well as parents, by health camps, seminars and through school magazines.

(iii) Refer answer 5(ii), Page 642
(MTG Excel in Chemistry)

(iv) Use of aspartame is limited to cold food and drinks because it is unstable at cooking temperature.

24. (a) (i) Refer answer 36(ii), Page 269
(MTG Excel in Chemistry)

(ii) Oxygen molecules are held together by weak van der Waals' forces because of the small size and high electronegativity of oxygen. Sulphur shows catenation and the molecule is made up of 8 atoms with strong intermolecular forces. Hence, there is large difference in the melting and boiling points of oxygen and sulphur.

(iii) Nitrogen does not form pentahalides due to unavailability of *d*-orbitals.

(b) (i) Refer answer 84(b), Part (iii), Page 293
(MTG Excel in Chemistry)

(ii) Refer answer 13(ii), Page 282
(MTG Excel in Chemistry)

OR

(i) White phosphorus is most reactive of all the allotropes because it is unstable due to the angular strain on P_4 molecule with bond angle of 60°.

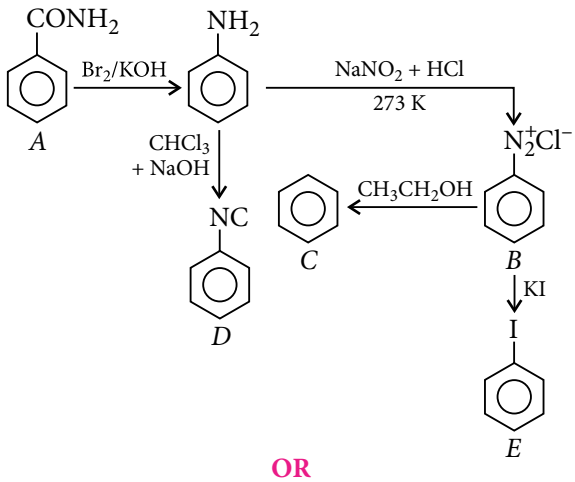
(ii) Nitrogen oxide emitted from the exhausts of supersonic jet aeroplanes readily combine with ozone to form nitrogen dioxide and diatomic oxygen. Since supersonic jets fly in the stratosphere near the ozone layer, they are responsible for the depletion of ozone layer.

(iii) F_2 has lower bond dissociation enthalpy than Cl_2 because F atom is very small and hence the electron-electron repulsions between the lone pairs of electrons are very large.

(iv) Helium is used for filling balloons for meteorological observations because it is non-inflammable.

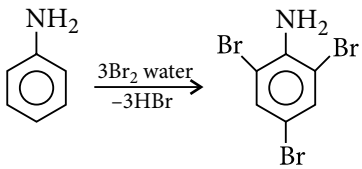
(v) $XeF_2 + PF_5 \longrightarrow [XeF]^+[PF_6]^-$

25.



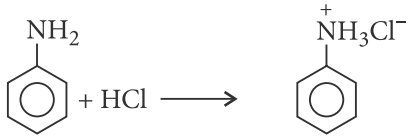
OR

(a) (i)



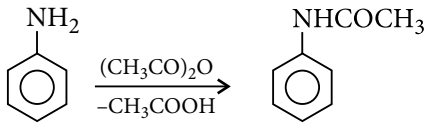
2,4,6-Tribromoaniline

(ii)



Anilinium chloride

(iii)



Acetanilide

(b) Increasing order of boiling points:
$(CH_3)_3N < C_2H_5NH_2 < C_2H_5OH$
Tertiary amine does not have hydrogen to form hydrogen bonding and hydrogen bonding in alcohol is stronger than that of amines because oxygen is more electronegative than nitrogen.

(c) When treated with benzenesulphonyl chloride (Hinsberg's reagent) $(CH_3)_2NH$ forms insoluble *N*, *N*-dialkylbenzene sulphonamide which is insoluble in KOH whereas tertiary amine does not react at all.

26. (i) For a first order reaction,

$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]}$$

When $t = 30$ s

$$k = \frac{2.303}{30}\log\frac{0.60}{0.30} = \frac{2.303}{30}\times 0.3010$$
$$= 0.0231\ s^{-1}$$

When $t = 60$ s

$$k = \frac{2.303}{60}\log\frac{0.60}{0.15} = \frac{2.303}{60}\times 0.602$$
$$= 0.0231\ s^{-1}$$

As the value of k is constant at different time intervals, the reaction is first order w.r.t. ester when $[H_2O]$ is constant. Hence, it is pseudo first order reaction.

(ii) Average rate $= -\frac{C_2 - C_1}{t_2 - t_1} = \frac{-(0.15 - 0.30)}{60 - 30}$

$$= \frac{0.15}{30} = 5\times 10^{-3}\ \text{mol}\ L^{-1}s^{-1}$$

OR

(a) (i) From the rate law equation, order of reaction w.r.t. *B* is 2. Hence, if concentration of *B* is doubled, rate will become four times.

(ii) If *A* is present in large excess, rate of reaction will be independent of concentration of *A* and hence, order of reaction will be 2.

(b) $t_{50\%}$ or $t_{1/2} = 30$ minutes

$$\Rightarrow \quad k = \frac{0.693}{t_{1/2}} = \frac{0.693}{30} = 0.0231\ \text{min}^{-1}$$

$$t_{90\%} = \frac{2.303}{k}\log\frac{100}{100-90} = \frac{2.303}{0.0231}\log 10$$
$$= 99.69\ \text{minutes}$$

CONCEPT BOOSTER

Dear all!! Similar to the last article, this article also contains some good questions for competitive level.Keep practicing with time management. All the best for upcoming examinations. Take care!!

*Arunava Sarkar

ALCOHOLS, PHENOLS AND ETHERS

SINGLE CORRECT ANSWER TYPE

1. Arrange the followings according to the increasing order of reactivity with HI?

CH_3CH_2OH (I), CH_3OH (II), $(H_3C)_2CH-OH$ (III), $CH_3-C(CH_3)_2-OH$ (IV), C_6H_5OH (V)

(a) IV < III < II < I < V
(b) V < II < I < III < IV
(c) V < I < II < III < IV
(d) I ≈ II < V < III < IV

2. Which of the following orders is correct regarding the order of reactivity of 3°, 2° and 1° alcohols towards sodium metal?

(a) 3° < 2° < 1° (b) 2° < 1° < 3°
(c) 1° < 2° < 3° (d) 1° < 3° < 2°

3. An alkene, on ozonolysis gives one mole of ethanal and one mole of methanal. This alkene was obtained by the dehydration of an alcohol *X*. Identify *X*.

(a) $CH_3-CH(CH_3)-CH_2OH$
(b) $(CH_3)_2C(OH)CH_3$
(c) Both (a) and (b).
(d) None of these.

4. $CH_3-CH(CH_3)-CH=CH_2 \xrightarrow[\text{peroxide}]{HCl} \xrightarrow[(dil.)]{\text{aq. NaOH}} ?$

Identify the major product.

(a) $CH_3-CH(CH_3)-CH_2-CH_2-OH$
(b) $CH_3-C(CH_3)(OH)-CH_2CH_3$
(c) $CH_3-CH(OH)-CH_2-CH=CH_2$
(d) None of these.

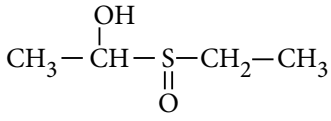
5. $(H_3C)_2CH-CH_2-CH_2-C(CH_3)(O)-CH_2 \xrightarrow{\text{aq. } LiAlH_4} ?$

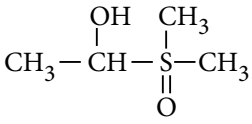
(a) $(H_3C)_2CH-(CH_2)_2-C(CH_3)(H)-CH_2OH$
(b) $(H_3C)_2CH-(CH_2)_2-C(CH_3)(OH)-CH_3$
(c) $(H_3C)_2C(OH)-(CH_2)_2-CH(CH_3)-CH_2OH$
(d) None of these.

6. $CH_3-CH(O)-CH-CH_3 \xrightarrow{Me_2SO,\ H^+}$ Major product

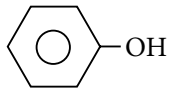
(a) $CH_3-CH(OH)-C(=O)-CH_3$
(b) $CH_3-CH_2-CH(OH)-CH_3$

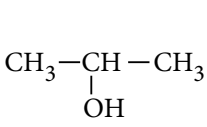
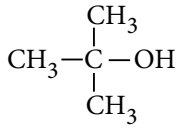
* Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna 09732313208

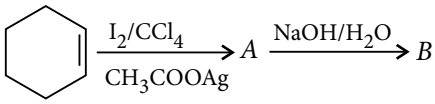
(c) 

(d) 

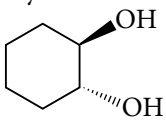
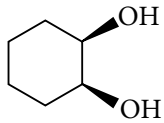
7. Which one is oxidised most easily among the followings?

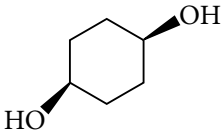
(a) $CH_3OCH_2CH_3$ (b) 

(c)  (d) 

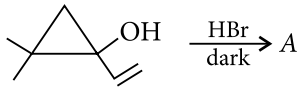
8. 

Identify *B*.

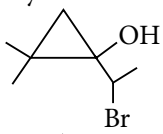
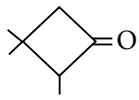
(a)  (b) 

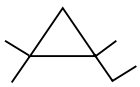
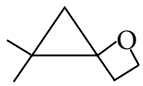
(c) 

(d) None of these.

9. 

Identify *A*.

(a)  (b) 

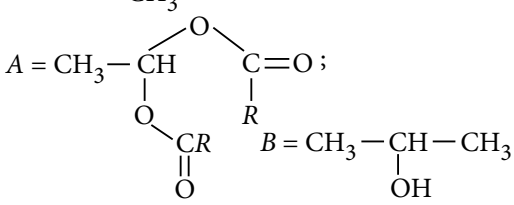
(c)  (d) 

10. Isobutene $\xrightarrow[CH_2Cl_2]{RCOOOH} A \xrightarrow[\text{ether}]{BF_3} B$

Identify *A* and *B*.

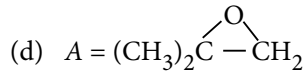
(a) $A = CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2COOR$;

$B = CH_3-\underset{\underset{CH_3}{|}}{CH}-O-CH_3$

(b) 

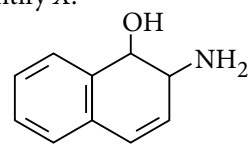
(c) $A = CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_2COOR$;

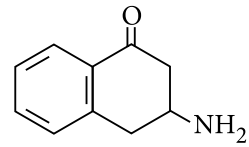
$B = CH_3-\underset{\underset{CH_3}{|}}{CH}-(CH_2)_2-\overset{-}{C}OO\overset{+}{B}F_3$

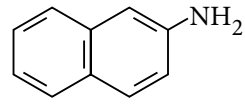
(d) 

11. β-Naphthol $\xrightarrow[NH_3]{NaHSO_3} X$

Identify *X*.

(a) 

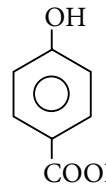
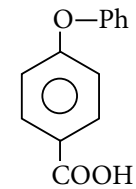
(b) 

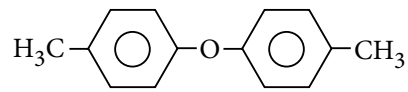
(c) 

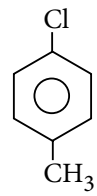
(d) None of these.

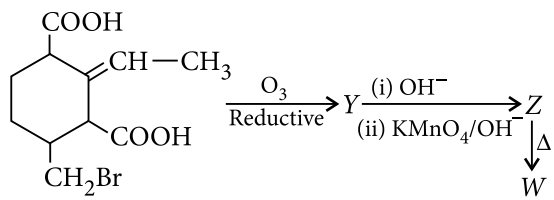
12. Identify the final product in the given sequence.

p-Cresol $\xrightarrow[NaOH]{PhSO_2Cl} \xrightarrow{H_3O^+}$

(a)  (b) 

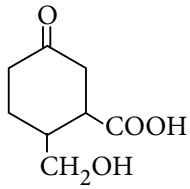
(c) 

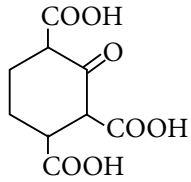
(d) 

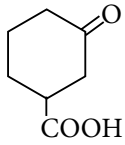
13. 

(*X*)

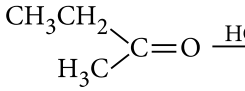
Identify *W*.

(a) 

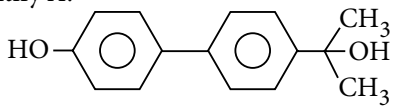
(b) 

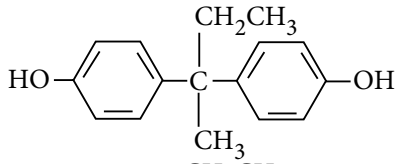
(c) 

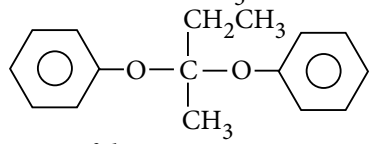
(d) None of these.

14. PhOH +  $\xrightarrow{HCl}$ *A*

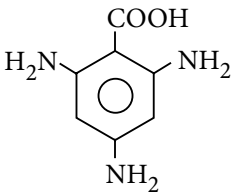
Identify *A*.

(a) 

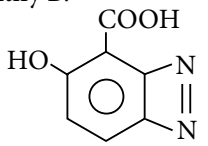
(b) 

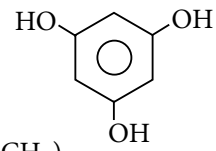
(c) 

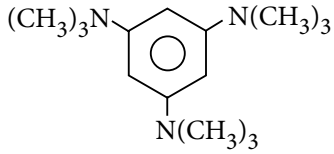
(d) None of these.

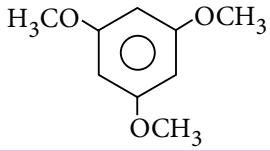
15.  $\xrightarrow[(ii)\ \Delta]{(i)\ H_3O^+}$ *A* $\xrightarrow[CH_3I\ (excess)]{NaOH(excess)}$ *B*

Identify *B*.

(a) 

(b) 

(c) 

(d) 

SOLUTIONS

1. **(c) :** $R-OH + HX \longrightarrow RX + H_2O$

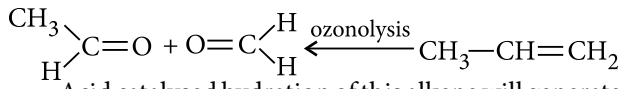
Here, cleavage of $\rangle C-OH$ bond takes place. 1° alcohols follow S_N2 path and most of the 2° alcohols and 3° alcohols follow S_N1 path. *+I* effect of the alkyl groups help in the shifting of bond pairs between carbon and —OH towards the oxygen atom. Hence, the breaking of $\rangle C-OH$ bond gets facilitated. Phenols do not undergo the breaking of $\rangle C-OH$ bond as phenols are more acidic than alcohols and due to *+R* effect of $-\ddot{O}H$ group, there is a partial double bond character between benzene ring and —OH group. CH_3OH has lesser steric hindrance and will have faster reactivity than CH_3CH_2OH in S_N2 path. Therefore, the order of reactivity will be :

$C_6H_5OH < CH_3CH_2OH < CH_3OH$

$< CH_3-\underset{CH_3}{\overset{}{CH}}-OH < H_3C-\underset{CH_3}{\overset{CH_3}{C}}-OH$

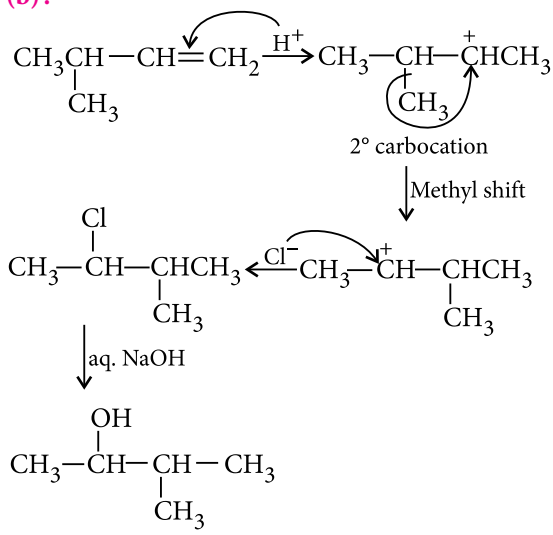
2. **(a) :** $-O-H$ bond has to be broken while reacting with sodium metal. So, order of reactivity will be $3° < 2° < 1°$.

3. **(d) :** The alkene is



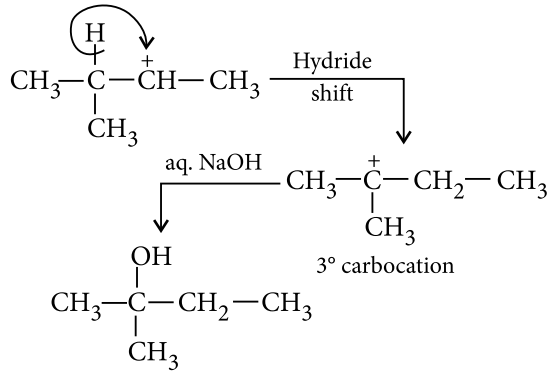
Acid catalysed hydration of this alkene will generate $CH_3-\underset{OH}{\overset{}{CH}}-CH_3$.

4. **(b) :**

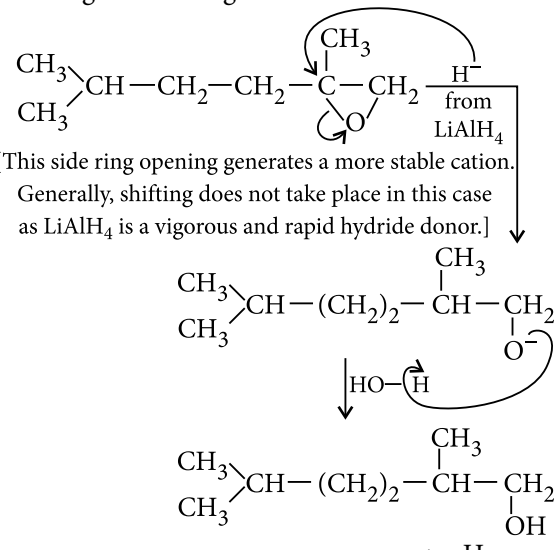


3-Methylbutan-2-ol

Even if someone does not make the shift or forgets to do the same then same product is formed. But technically it is wrong because, shifting should give a more stable carbocation. So, in the above case, it will be hydride shift and not the methyl shift.

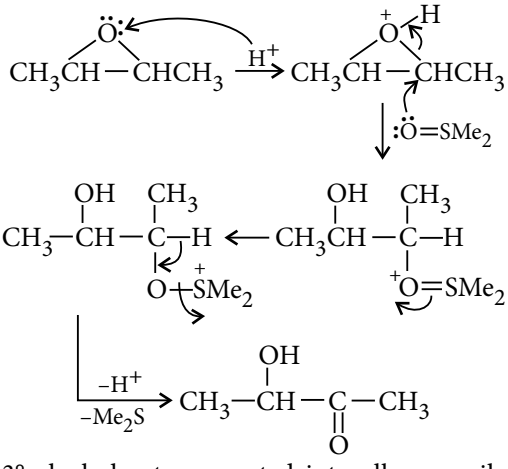


5. **(a) :** Epoxides are unstable (specially a three membered ring).
It undergoes breaking as follow:

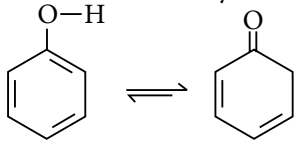


[This side ring opening generates a more stable cation. Generally, shifting does not take place in this case as $LiAlH_4$ is a vigorous and rapid hydride donor.]

6. **(a) :**

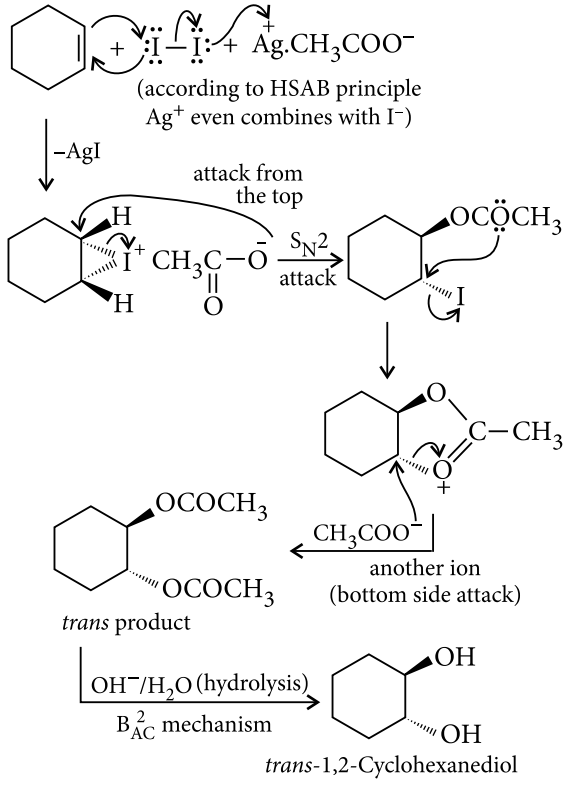


7. **(c) :** 3° alcohol gets converted into alkene easily. Phenol is resonance stabilised. Its conversion into ketone will vanish aromaticity.

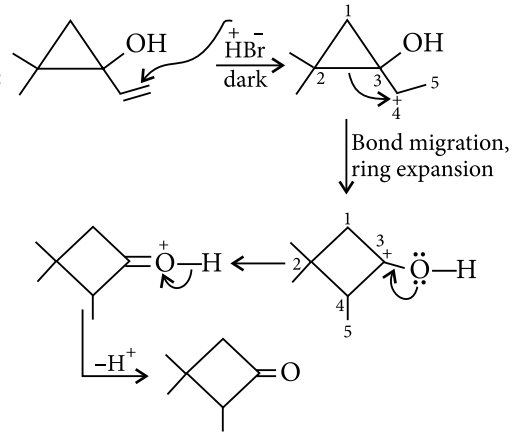


Ethers are not easily oxidisable. When exposed to air and light for long time ethers are oxidised to peroxides.

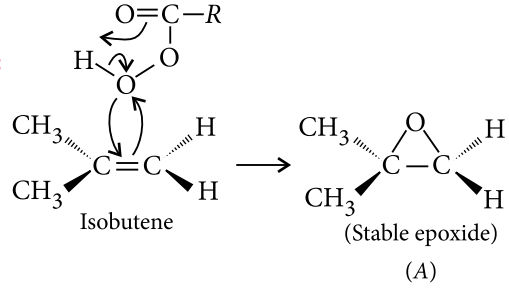
8. **(a) :** This reaction is known as Prevost reaction.

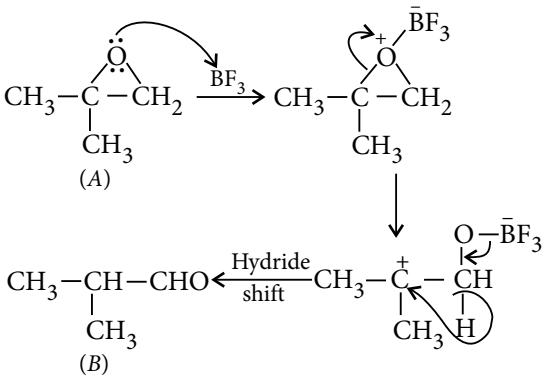


9. **(b) :**

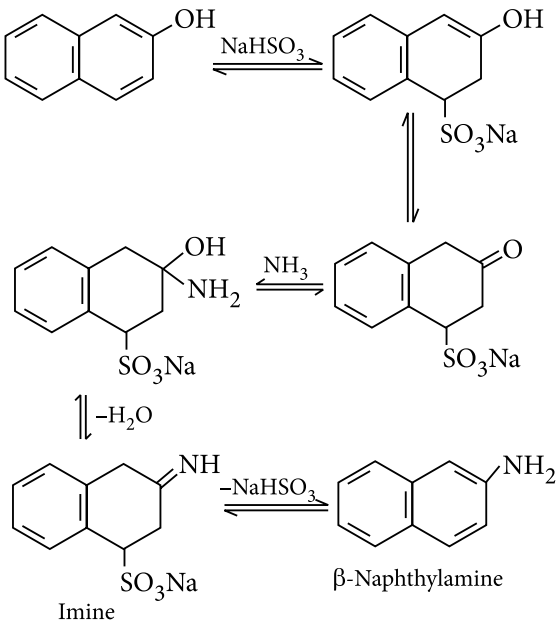


10. **(d) :**

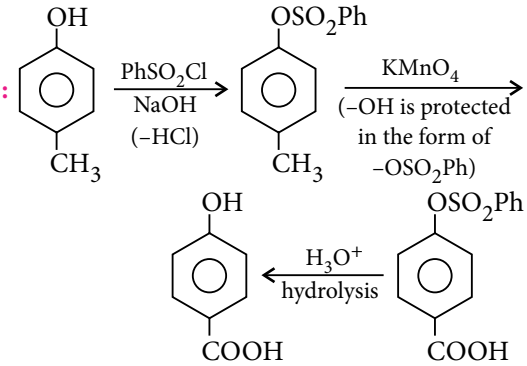




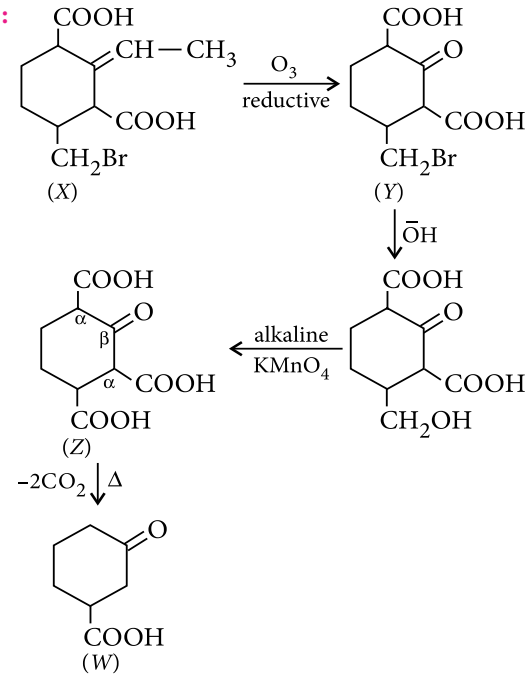
11. (c) : This reaction is known as Bucherer reaction.



12. (a) :

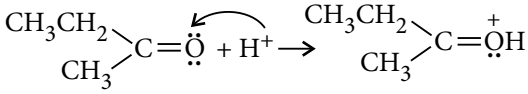


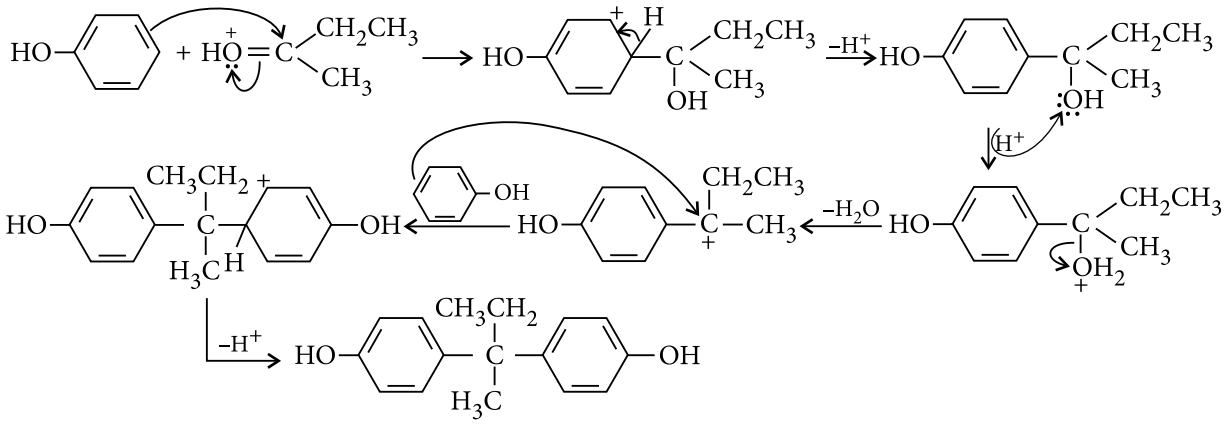
13. (c) :



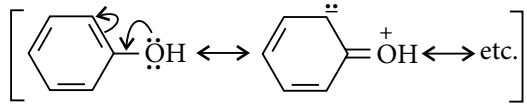
β-Ketocarboxylic acids decarboxylate easily.

14. (b): First, H^+ (from HCl) will protonate the carbonyl group of the ketone.

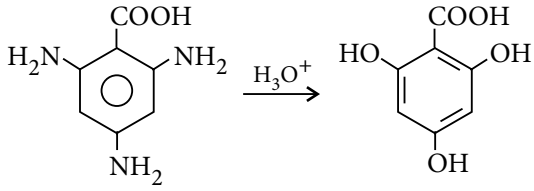




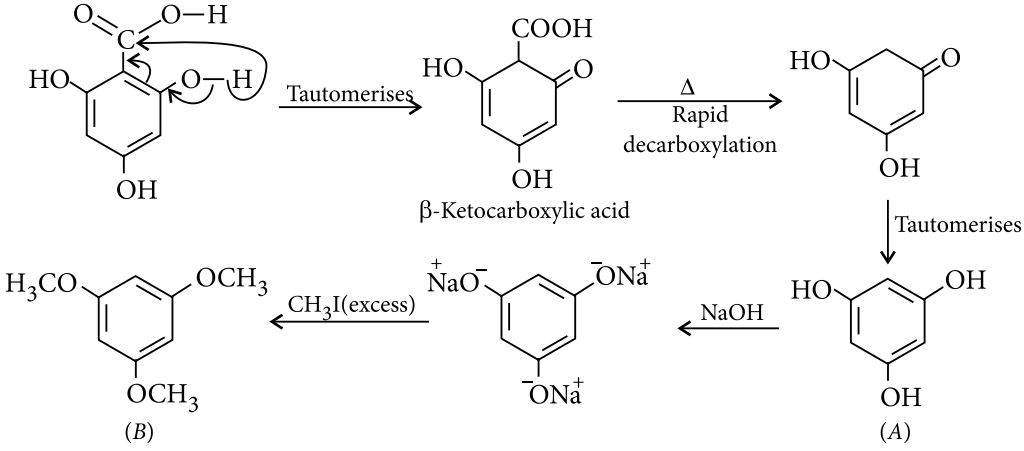
Note : Phenol will not give lone pair of oxygen as there is a partial bond between oxygen atom and between benzene ring.



15. (d):



This is taking place through aromatic nucleophilic substitution. $\overset{+}{N}H_3$ is formed which is a good leaving group and moreover a deactivating — COOH group is there.

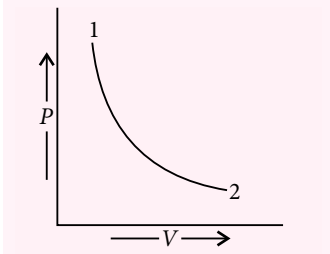


ADVANCED CHEMISTRY BLOC

(THERMODYNAMICS)

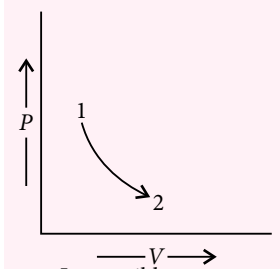
Mukul C. Ray, Odisha

Reversible and Irreversible Processes



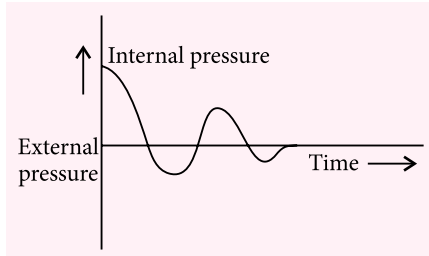
Reversible and *ipso-facto*(by the fact itself) Quasi-static process

To be very precise reversible processes in thermodynamics are those, which can be restored at any stage by an infinitesimal change in conditions. Reversal of process will restore both the system and the surroundings to their initial conditions. It is very simple. Imagine a frictionless, weightless piston carrying out a finite volume change in infinite number of infinitesimal steps that take infinite amount of time. When the expansion (say, may be compression) goes on, whatever energy is exchanged between the system and surroundings is exactly restored during the compression. If some energy is lost by the system due to friction of piston with the wall during expansion, it will not be regained by the system during compression, though energy is spent to overpower the friction even during the compression. Therefore, there should not be any friction for a reversible process. No such processes really exist. It has been cooked up like cooking up resistance less wire, frictionless pulley in physics.



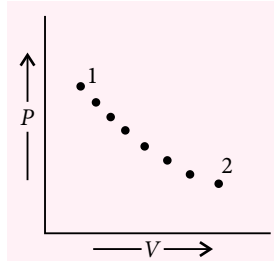
Irreversible process

In an irreversible process, the volume and corresponding pressure are not know throughout so a solid line cannot be drawn. Just analyze a process of sudden expansion; initially the pressure exactly at the bottom of the piston becomes even lower than the external pressure creating turbulence then it slowly rises again and this rise and fall continues till internal pressure becomes same as external one.



Variation of average internal pressure against time during a sudden expansion

The irreversible process may be made to occur infinitely slowly, that is quasistatically. Nevertheless, even in the limit such a process would retain the essential features of an irreversible process. In particular, it would proceed in definite direction, and change in direction would not cause the system as well as surroundings to traverse the same sequence of steps, but in the opposite direction. As explained earlier when the piston moves with friction, the local temperature near the rubbing surface would increase regardless of whether the gas is compressed or expanded. This means by reversing the process, things are not exactly reversed. When a system performs a quasi-static irreversible process, it departs from exact equilibrium only slightly. It is then said to be in near equilibrium. Under the circumstances the image of the process can be approximated by a continuous line in a state diagram.



Quasi-static process (Irreversible process)

Heat Capacities

Leaving aside the definitions,

$$C_p = \frac{dq_p}{dT}$$

$$C_v = \frac{dq_v}{dT}$$

These equations are valid only for irreversible processes. In irreversible heating the system may develop temperature gradient, and then there will be no single temperature assignable to the system. If T is undefined, dT is also undefined.

Again,

$C_p = \left(\frac{\partial H}{\partial T}\right)_p$, Valid for closed system in equilibrium, P-V work only.

$C_v = \left(\frac{\partial U}{\partial T}\right)_v$, Valid for closed system in equilibrium, P-V work only.

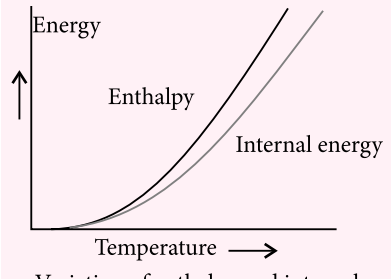
Since $H = f(T, P)$ partial derivative is taken. For an ideal gas, however, H is a function of temperature only so differential is taken instead of partial differential:

$C_p = \frac{dH}{dT}$, Valid for perfect gas, closed system in equilibrium, P-V work only.

Similarly,

$C_v = \frac{dU}{dT}$, Valid for perfect gas, closed system in equilibrium, P-V work only.

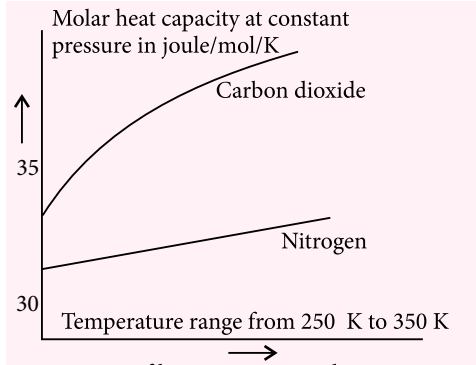
At any temperature, enthalpy (H) is higher than internal energy (U) and the difference increases with increase in temperature. The slopes of these lines are C_p and C_v respectively.



Variation of enthalpy and internal energy with temperature

With increase in temperature heat capacities increase. Very simple it is, a molecule have various energy modes, which include translational, rotational and vibrational. All these modes are quantized. At low temperature only translational modes absorb heat and this absorption contribute to temperature rise. Translational modes are active even down to zero Kelvin. Therefore, the minimum C_v value of a gas is $1.5R$.

Beyond a certain temperature, rotational modes become active; they soak heat but without contributing to temperature rise. It means to get one-degree temperature rise; more heat has to be supplied at higher temperature. This becomes still more when vibrational modes become active.



Variation of heat capacities with temperature

Now note,

$C_v^{real} = C_v^{ideal}$ and $C_p^{real} > C_p^{ideal}$

At constant volume the mean distance between the molecules does not change so the influence of the forces of attraction existing in between the real gas molecules has no significance. In case the pressure is constant, the mean distance between the molecules grows. In order to compensate this supplementary heat must be supplied.

Calculation of q, w, ΔU and ΔH

- **Reversible phase change at constant temperature and pressure**

  Say melting of ice or conversion of graphite to diamond

  $w = -P\Delta V$

  This volume change is calculated using densities of two phases. If one phase is gas, $PV = nRT$ is used to find its volume.

  $\Delta H = q_p = q$

  $\Delta U = q + w$

- **Constant pressure heating with no phase change**

  A constant pressure process is mechanically reversible.

  $w = w_{rev} = -P\Delta V$ at constant P

  If heating or cooling is reversible T is well defined,

  $$\Delta H = q_p = \int_{T_1}^{T_2} C_p dT$$

Even for an irreversible process this calculation holds as change in enthalpy is a state function. The dependence of C_p on pressure is rather weak. Unless at high pressure, C_p at 1 atm can be used at other pressure. When C_p is constant in the said temperature range, it is held constant during the integration.

$$\Delta U = q + w$$

- **Constant volume with no phase change**

$$w = 0$$

$$\Delta U = q_v = \int_{T_1}^{T_2} C_v dT$$

Applicable both for reversible and irreversible processes.

$$\Delta H = \Delta U + \Delta(PV)$$

- **Perfect gas change of state**

$$\Delta U = C_v \Delta T$$

$$\Delta H = C_p \Delta T$$

Since enthalpy and internal energy for perfect gas depend only on temperature, applicable both for reversible and irreversible processes.

$$w_{rev} = -\int_1^2 PdV$$

To find q, use $\Delta U = q + w$

- **Reversible isothermal process for perfect gas**

$$\Delta U = 0, \quad \Delta H = 0$$

$$w = -\int_1^2 PdV$$

$$q + w = 0$$

- **Reversible adiabatic process for perfect gas**

$$q = 0$$

$$\Delta U = \int C_v dT$$

$$\Delta H = \int C_p dT$$

and $w = \Delta U$

The final state of the gas can be found by

$$PV^{\gamma} = \text{Constant}$$

- **Adiabatic expansion of perfect gas into vacuum**

$$q = 0\,; \quad w = 0$$

$$\Delta U = q + w = 0$$

$$\Delta H = \Delta U + P\Delta V = \Delta U + \Delta T(nR) = 0$$

YOU ASKED WE ANSWERED

Do you have a question that you just can't get answered?

Use the vast expertise of our mtg team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough.

The best questions and their solutions will be printed in this column each month.

Q1. Some aldehydes and ketones are used for making perfumes. Please specify the names of chemicals.

–Akshay kumar, Bhagalpur (Bihar)

Ans. Hardly a fragrance exists without some kind of aldehyde or ketone in it. Often the compounds are patented under commercial names, therefore their true nature remain unknown.

Most widely used aldehydes in perfumery are :

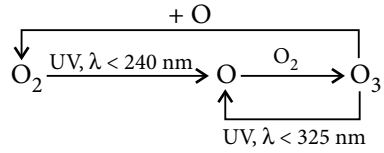
- Benzaldehyde is an example which is the simplest aromatic aldehyde having a pleasant almond-like odour. Cinnamaldehyde (3-phenylprop-2-enal) is of complex structure that gives cinnamon note. Vanillin (4-hydroxy-3-methoxybenzaldehyde) is used as vanilla note, an ubiquitous note in almost all fragrances. Anisaldehyde or anisic aldehyde is widely used for its good tenacity. It is the main component for numerous floral accords like lilac, hawthorn, anise, etc.
- The hydrocinnamic aldehydes are another family of materials derived from benzene and their odour profile resembles lily of the valley (muguet) and cyclamen. One of them is the famous 'Lilial', widely used in the replication of natural essence, lily of the valley. Another is Cyclamen aldehyde usually produced with cumene as a starting material.
- Some other aldehydes and ketones used in perfumery are heptanal - naturally occurring in clary sage and possessing a herbal odour, octanal - orange-like, nonanal - smelling of roses, decanal - powerfully evocative of orange rind; citral - a more complicated 10-carbon aldehyde has the odour of lemons, undecanal - naturally present in coriander leaf oil, lauryl aldehyde-evocative of lilacs or violets.

Q2. Ozone is heavier than oxygen, then why it remains higher than O_2 in atmosphere?

–S. Majumdar, (West Bengal)

Ans. Ozone is found throughout the atmosphere, even at ground level. Ozone layer is simply an area in the atmosphere where ozone is in higher concentration (5 – 10 ppm). Oxygen is present in the ozone layer as well.

Ozone is an unstable molecule and the same mechanism that typically forms ozone also breaks it down.



The Chapman mechanism of ozone formation

At high altitudes, the pressure, the molecular density and the rate of molecular collisions are very low. On the other hand, below 20 km insufficient oxygen atoms are present to generate ozone as all the light energetic enough to split oxygen molecules into oxygen atoms has already been absorbed. Therefore, the ozone layer is between 20 km and 35 km above the earth's surface.

Q3. Which type of reagents is the cation of Eschenmoser's salt?

– Saurabh Kumar, Punjab

Ans. Eschenmoser's salt is an iminium salt, which involves a heteroanalogue of carbonyl group. Thus, Eschenmoser's salt is an electrophile with electrophilic carbon center similar to the carbonyl carbon. Formally, it should behave as a stabilized carbonium ion, as it is well seen by considering the reasonance forms :

$$\underset{\text{(I)}}{H_2C{=}\overset{+}{N}Me_2} \longleftrightarrow \underset{\text{(II)}}{H_2\overset{+}{C}{-}\ddot{N}Me_2}$$

Due to very high π-donicity of dimethylamino group, the first form predominates, and thus nucleophilic properties, which may be attributed to the second form, are virtually missing. It can be considered a Lewis acid as any C-electrophile is, due to apparent ability to combine with bases, *e.g.*, hydroxide ion or water. Thus, it can act as an electrophile, a Lewis acid or a nucleophile.

CHEMISTRY MUSING

SOLUTION SET 20

1. (d)

2. (a) :

$4HCl_{(g)} \longrightarrow 2H_{2(g)} + 2Cl_{2(g)}$; + 370 kJ/mol

$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$; – 483.7 kJ/mol

$4HCl_{(g)} + O_{2(g)} \longrightarrow 2Cl_{2(g)} + 2H_2O_{(g)}$; – 113.7 kJ/mol

q = – 113.7 kJ($\because$ $\Delta H^\circ = q_p$ at constant pressure)

Δn = 4 – 5 = – 1 mol, $w = -\Delta nRT$

$$w = -(-1.0 \text{ mol})\left(\frac{8.314 \text{ J}}{\text{mol K}}\right)(298 \text{ K}) = 2.48 \text{ kJ}$$

According to the Ist law,

$\Delta E = q + w$ = – 113.7 kJ + 2.48 kJ = – 111.22 kJ

3. (c) : $N_2 \Rightarrow$ Diamagnetic, B.O. = 3.0

$N_2^+ \Rightarrow$ Paramagnetic, B.O. = 2.5

$C_2 \Rightarrow$ Diamagnetic, B.O. = 2.0

$C_2^+ \Rightarrow$ Paramagnetic, B.O. = 1.5

$NO \Rightarrow$ Paramagnetic, B.O. = 2.5

$NO^+ \Rightarrow$ Diamagnetic, B.O. = 3.0

$O_2 \Rightarrow$ Paramagnetic, B.O. = 2.0

$O_2^+ \Rightarrow$ Paramagnetic, B.O. = 2.5

4. (d) : $PV = nRT$, at constant T, $PV \propto n$

Before reaction, $n_{NO} \propto (0.500 \text{ atm})(4.00 \text{ L}) = 2.00$

$n_{O_2} \propto (1.00 \text{ atm})(2.00 \text{ L}) = 2.00$

	$2NO_{(g)}$ +	$O_{2(g)}$ $\longrightarrow$	$2NO_{2(g)}$
Initially	2.00 moles	2.00 moles	0 mole
Finally	0 mole	1.00 mole	2.00 moles

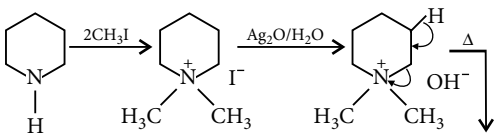
($\because$ as per the reaction, 2 moles of NO reacts with 1 mole of O_2 to give 2 moles of NO_2.)

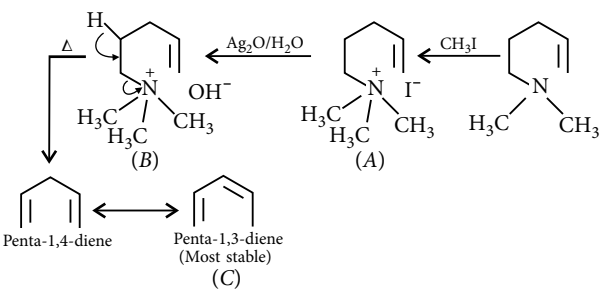
At the end of reaction, total volume is 6.00 L.

$$p_{O_2} \propto \frac{n_{O_2}}{V} = \frac{1.00}{6.00} = 0.167 \text{ atm}$$

$$p_{NO_2} \propto \frac{n_{NO_2}}{V} = \frac{2.00}{6.00} = 0.333 \text{ atm}$$

5. (a) :

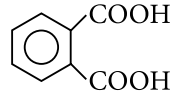




6. (a) : Degree of unsaturation in '*A*' (C_9H_8)

$$= \frac{2C - H + 2}{2} = \frac{18 - 8 + 2}{2} = 6$$

Vigorous oxidation of '*A*' gives phthalic acid,



Degree of unsaturation due to benzene ring

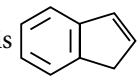
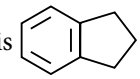
= 1(ring) + 3(C = C) = 4

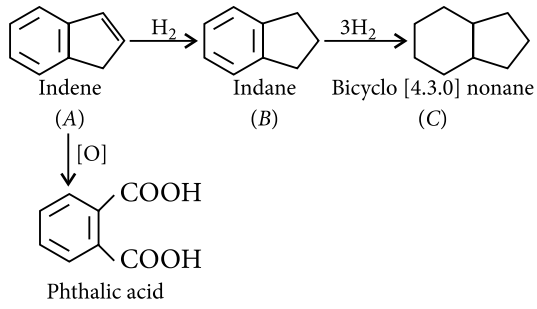
Under mild conditions '*A*' adds one equivalent of H_2, showing one degree of unsaturation.

Thus, sixth degree of unsaturation is due to another ring.

Thus, total of six degree of unsaturation is due to two rings and four (C = C).

Formation of phthalic acid indicates that another ring is fused at *ortho*-position.

Thus, *A* is  and *B* is 



7. (d) : Both ClO_2^- (17 + 2 × 8 + 1) and ClF_2^+ (17 + 2 × 9 – 1) have 34 electrons.

8. (d) : Pseudohalide – OCN^-

Polyhalide – BrI_2^-

Interhalogen – IF_5

9. (6) : Amount of oxalic acid present initially

$$= 1 \times \frac{50}{1000} \times 126 = 6.30 \text{ g}$$

Amount of oxalic acid present after adsorption

$$= 0.5 \times \frac{50}{1000} \times 126 = 3.15 \text{ g}$$

Amount of oxalic acid adsorbed by 0.5 g of wood charcoal = 6.30 – 3.15 = 3.15 g

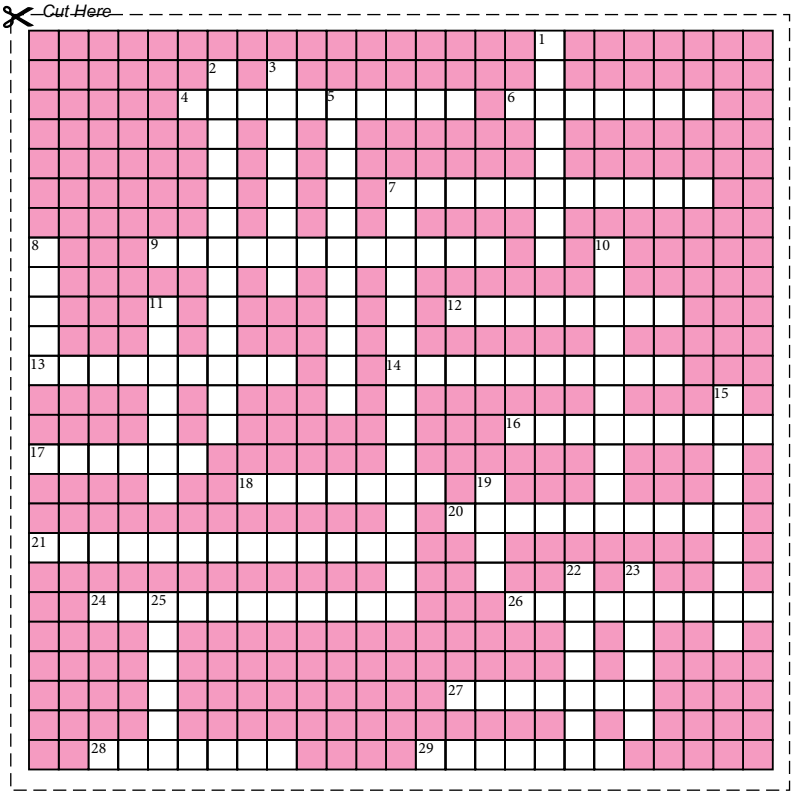
Amount of oxalic acid adsorbed per gram of carbon = 3.15 × 2 = 6.30 g ≈ 6 g

10. (5) : Only those aldehydes which do not contain α-hydrogen will undergo Cannizzaro reaction. Thus, methanal, benzaldehyde, 2, 2-dimethylbutanal will undergo Cannizzaro reaction and others will not.

CROSSWORD

Readers can send their answer with complete address before 15th of every month to win exciting prizes.
Winners' name with their valuable feedback will be published in next issue.

Cut Here



ACROSS

4. The downward growth of $CaCO_3$ formed on the roof of a cave by trickling of water containing calcium compounds. (10)

6. The method by which a carbonyl compound can be converted into a dithio-acetal or ketal. (7)

7. A sulphur-nitrogen compound whose conductivity increases with decreasing temperature. (11)

9. Emission of cold light. (12)

12. Jeweller's rouge. (8)

13. The ion which do not undergo any electronic change during a chemical reaction. (9)

14. Another name of methyl *tert*-butyl ketone. (10)

16. Shrinking of gels by loosing some of the liquid held by them. (9)

17. Phenol that gives deep purple colour with neutral $FeCl_3$. (6)

18. A stable hydrate of chlorine. (7)

20. A general anaesthetic. (10)

21. Antihaemorrhagic vitamin. (13)

24. The process in which the molecules like H_2O, CH_3OH are absorbed in the internal cavity of zeolite. (11)

26. An organometallic species that reacts like a carbene. (9)

27. A refrigerant. (7)

28. A smokeless explosive. (7)

29. Conversion of a baser metal into a precious metal by artificial disintegration. (7)

DOWN

1. Substance that emits flashes of light when struck by radiation. (8)

2. The apparatus used for measuring surface tension. (13)

3. The removal of impurities from a mineral by forming molten salts. (8)

5. The phenomenon of disappearance of the boundary between two particles in contact. (11)

7. Indicator used for titration of weak acid versus strong base. (15)

8. Reagent that can convert 2° alcohol to ketone without affecting $\rangle C{=}C \langle$ double bond. (5)

10. Direct method of determination of molecular formula of gaseous hydrocarbons. (10)

11. A mixture of TiO_2 and $BaSO_4$. (7)

15. Quartz glass used in the manufacture of optical instruments. (9)

19. Area of nuclear cross section is expressed in___ . (4)

22. Heaviest transition element. (7)

23. Alloy of tin used in making utensils. (6)

25. Reaction used to prepare 1° amine containing a tertiary alkyl group. (6)

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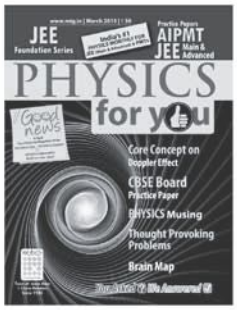

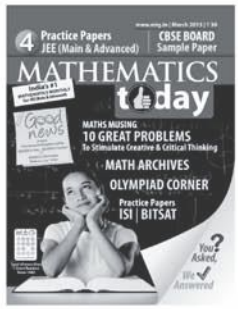

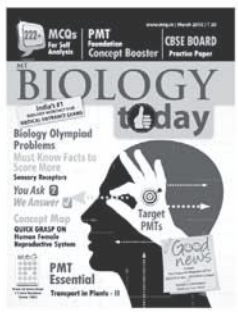

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